PHILIPS

Double-beam Oscilloscope
PM 3230

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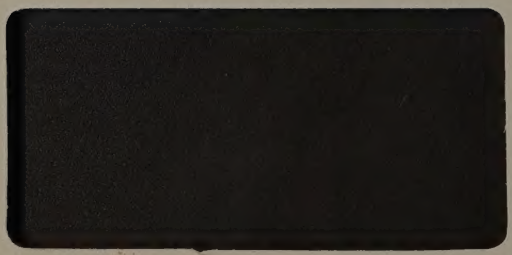
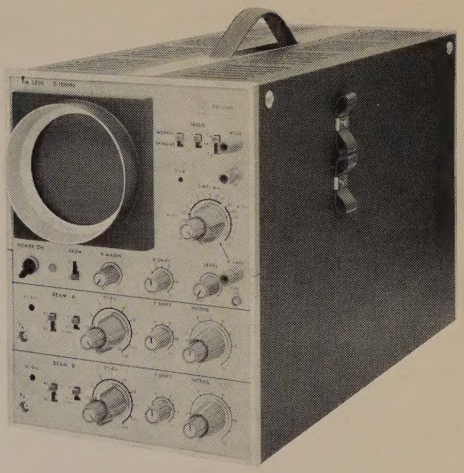
9499 440 05411

1/1168/1/09





PHILIPS

Manual

Double-beam Oscilloscope
PM 3230

9444 032 30 . . 1

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IMPORTANT !

In correspondence concerning this instrument always state the type number and the serial number as indicated on the type plate of the instrument.

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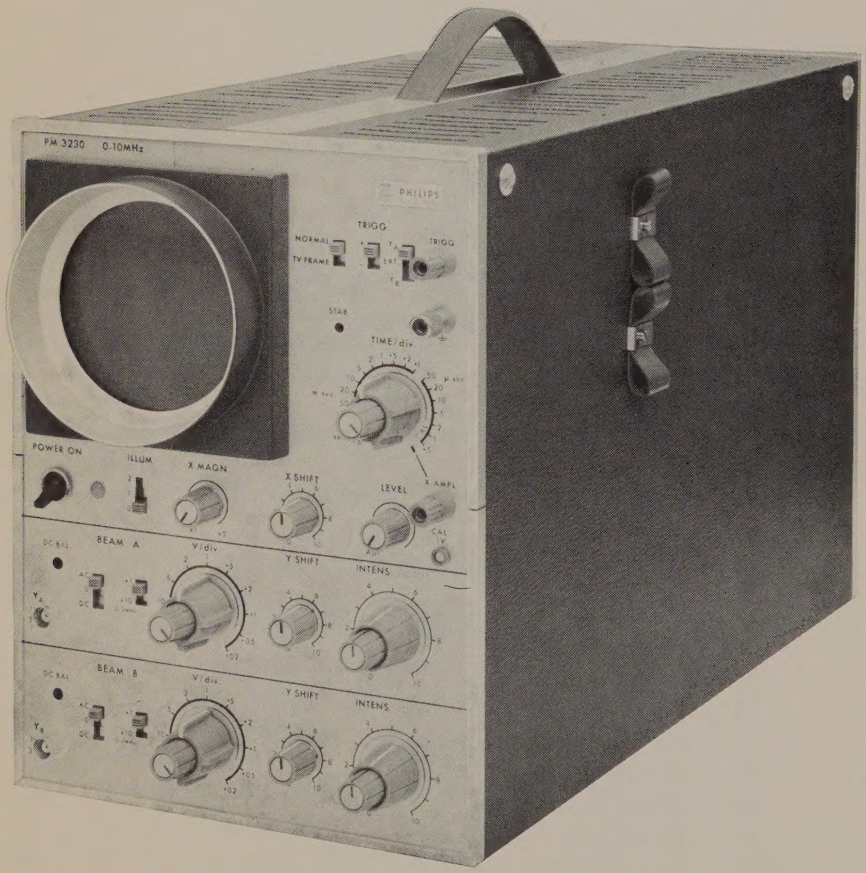


Fig. 1. Front view

GENERAL INFORMATION

1 *Introduction*

The double-beam oscilloscope PM 3230 has a double-gun cathode-ray tube which provides high brillance and a fine spot.
The two identical vertical amplifiers, the horizontal amplifier and the time-base generator are transistorised with exception of the output stages. Focusing and intensity controls for both beams are independently adjustable.

II *Technical data*

Vertical amplifiers

Frequency range	Normal DC coupled 0 to 10 MHz (–3dB) AC coupled 2 Hz to 10 MHz (–3dB) Rise time 35 nano-seconds When x10 amplifier is used: DC coupled 0 to 2 MHz (–3dB) AC coupled 2 Hz to 2 MHz (–3dB) Rise time 175 nano-seconds
Deflection factor	x1 mode: 20 milli-volts per division to 50 volts per division, in 11 calibrated steps (1, 2, 5 sequence). x10 mode: increases maximum sensitivity to 2 milivolts per division. Vernier allows continuous control between the ranges.
Measuring accuracy	In all ranges 3 %.
Input impedance	1 megohm in parallel with 30 pF.
Maximum input voltage	500 volts (DC + AC peak).
Maximum deflection	For sine waveforms of frequencies up to 0.1 MHz, vertical deflection is undistorted for a total amplitude equivalent to 24 divisions. Any 8 divisions of such a waveform can be displayed.
DC balance	DC balance controls are available on the front panel for correction of possible differential drift in the first stages of the amplifier.
DC drift	After warming up smaller than 4 divisions per hour.
Calibration voltage	For adjustment of the sensitivity of the vertical amplifiers and square-wave response of the probes. A square-wave voltage is available on a front-panel socket. The amplitude is 1 volt peak-to-peak, $\pm$ 1 %, the frequency is approximately 8,000 Hz.

Time-base generator

Sweep speeds	0.5 micro-second per division to 0.5 second per division, in 19 calibrated steps (1, 2, 5 sequence). Continuous control between the steps is possible.
Accuracy	± 5 %
Expansion	The horizontal sweep can be expanded up to 5 times (50 divisions) by a continuous, uncalibrated control. Any 10 divisions of the expanded sweep can be displayed. At maximum expansion the fastest sweep speed is 100 nano-seconds per division.
Saw-tooth voltage	A saw-tooth voltage of 5 volts peak-to-peak is available on a socket at the rear of the instrument.

Triggering

Trigger facilities	The time-base generator operates in the triggered mode only and from either the positive- or negative-going edge of the trigger signal. The trigger level is adjusted by a front-panel control. The trigger-stability control, which seldom requires adjustment, is a screw-driver preset on the front panel.
Trigger source	Internally from either vertical amplifier, or externally. The triggering is AC coupled.
Trigger mode	Automatic triggering or triggering with continuously variable level.
Trigger sensitivity	The following table indicates the minimum value at which stable triggering occurs.

Trigger source	Trigger mode	Reference values for sine-wave signals (Normal)		TV signals (TV frame)
		10 Hz to 1 MHz	1 MHz to 5 MHz	
internal	auto	2 divisions		
	level	0,5 divisions	4 divisions	2 divisions
external	auto	1 volt peak-to-peak	1 volt peak-to-peak	
	level	1 volt peak-to-peak	1 volt peak-to-peak	1 volt peak-to-peak

Trigger level	Continuously variable over 8 divisions for internal or 8 volts for external triggering.
Trigger input impedance	50,000 ohm in parallel with 12 pF.

Horizontal amplifier

Frequency range	0 to 1 MHz (–3dB) with X-magnifier in position x1.
Deflection factor	Continuously adjustable between 100 milli-volts per division and 500 milli-volts per division.
Input impedance	0.5 megohm in parallel with 60 pF.
Maximum input voltage	50 volts (DC + AC peak).
Maximum deflection	For sine waveforms of frequencies up to 0.2 MHz, horizontal deflection is undistorted for a total amplitude equivalent to 50 divisions. Any 10 divisions of such a waveform can be displayed.

Power supply

Mains voltage	100 to 125 volts (110 volts nominal) or 200 to 250 volts (220 volts nominal) AC.
Mains frequencies	50 to 400 Hz.
Power consumption	85 watts.

A compartment for the mains cable is provided.

Display

Cathode-ray tube	10 cm (4″) tube with 4,000 volts acceleration voltage.
Tube type	E10-12.
Maximum undistorted deflection	Vertical up to 8 divisions and horizontal up to 10 divisions for both guns.
Division size	8 mm (0.312″).
Screen type	GP (P2), medium short persistance, bluish green. GH (P31) and GM (P7) types optional.
Brilliance and focussing	Controls for each gun are on the front panel.
Beam control	The unblanking during the sweep is achieved by beam deflection and is DC coupled.
Beam modulation	External Z modulation is achieved by using the Wehnelt cylinder of each gun. An input to each gun is available on the rear panel of the instrument. Input voltage required for Z-modulation is in the order of 15 volts peak-to-peak, for frequencies from 10 Hz to 1 MHz. Input impedance: 1 megohm in parallel with 60 pF. Input RC time via blocking capacitor: 0.01 seconds.
Graticule illumination	Three fixed levels for simple camera settings.

Dimensions and weight

Height 30 cm (11¾″) Width 21 cm (8¼″)
Length 45 cm (18″) Weight 11 kg (24 lbs)

Properties expressed in numerical values with tolerances stated are guaranteed by the factory. Numerical values without tolerances mentioned represent the properties of an average instrument and merely serve as a guide. All data apply in case of nominal mains voltage unless otherwise stated

Fig. 2. Probe set PM 9327

III Accessories

Supplied with the instrument are:

A manual
Two BNC to 4-mm banana-plug adapters PM 9051
A plastic dust cover

Optional accessories

Probe set; probe cable 1.15 m (3¾′)	: PM9326
Probe set; probe cable 2 m (6½′)	: PM9327
Rubber viewing hood	: PM9370
Carrying case	: PM9303

IV *Block diagram*

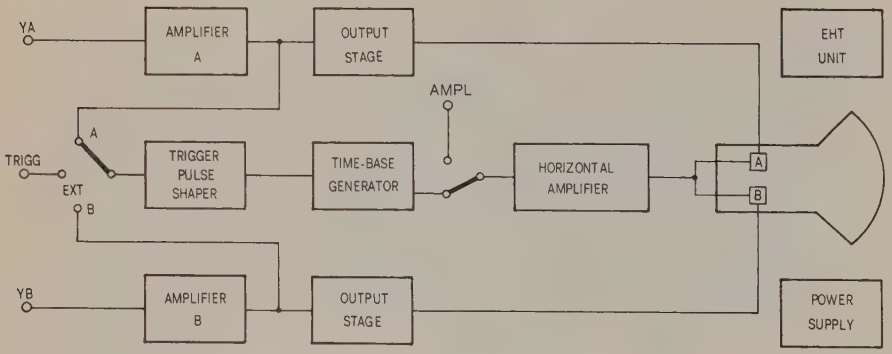


Fig. 3. Block diagram

PEM 1219
E 978

The oscilloscope consists of the following separate stages:

- two identical d.c. amplifiers for vertical deflection. The deflection factors can be varied both in steps and continuously.
- a d.c. amplifier for horizontal deflection. This amplifier can be driven either with the internal time-base voltage or an external voltage.
- a trigger-pulse shaper which ensures stable triggering independent of the shape of the input signal.
- a time-base generator (Bootstrap integrator) which delivers a sawtooth voltage.

  The sweep speeds are calibrated and can be varied both continuously and in steps.

  The time-base generator can work in the triggered mode (AC, AUT. or TV FRAME, whereby the selected trigger signal can be derived from one of the Y-amplifiers or fed from an external source).
- a cathode-ray tube with two identical gun assemblies and deflection systems.

  The brightness and focus of both beams can be independently adjusted.
- a power supply which delivers several electronically stabilized d.c. voltages.
- a high-voltage unit which delivers a stable and mains-voltage independent voltage for the cathode-ray tube as well as a calibration voltage for the adjustment of the sensitivity of the Y-amplifiers and attenuator probes.

DIRECTIONS FOR USE

V *Installation*

A. ADJUSTING TO THE LOCAL MAINS VOLTAGE

By delivery, the instrument has been adjusted to a mains voltage of 200... 250 V (220 V nominal). If the local mains voltage amounts to 100...125 V (110 V nominal), the mains-voltage selector situated at the rear of the instrument should be switched over.

This procedure is effected as follows:

– Unscrew the locking screw "S" slightly by turning it anti-clockwise (Fig. 4).

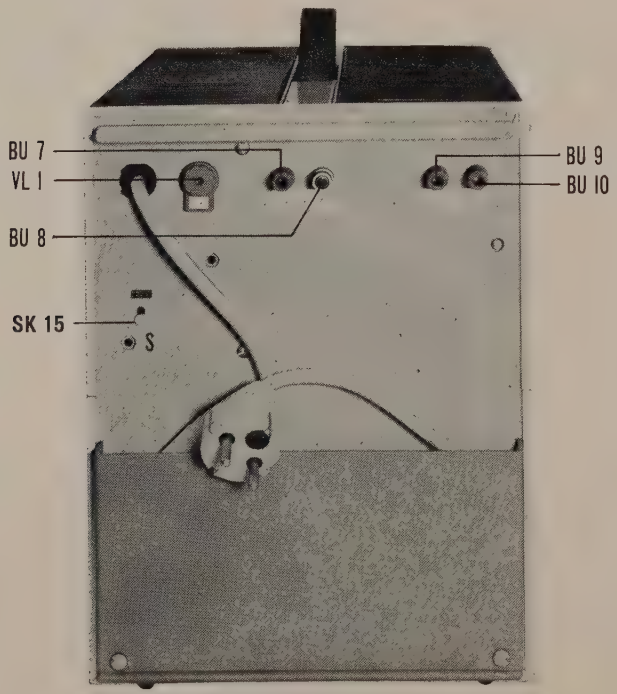


Fig. 4. Rear view

– Push the locking screw in upward direction until the value "110 V" is visible through the opening in the rear panel.
– Tighten the locking screw by turning it clockwise.

When the nominal mains voltage is 127 V, the voltage across the primary of the supply transformer exceeds the permissible value of 110 V + 15 %. To prevent this a resistor is fitted which can be incorporated in series with the primary winding. When doing so, the blue cable on the right (Br), which is connected to point 1, should be loosened and connected to point 5 (see Fig. 4a).

B. EARTHING

The instrument must be earthed according to the local safety regulations. This can be effected:

1. Via one of the earthing sockets on the instrument; or
2. Via the mains cable (the instrument is equipped with a three-core mains cable).

Double earthing leads should be avoided as these give rise to undesirable hum

C. CONNECTION TO THE MAINS

– Ensure that the mains-voltage selector is set to the correct value.
– Earth the instrument.
– Connect the instrument to the mains.
– Set the mains switch to "POWER ON". The pilot lamp will light up.

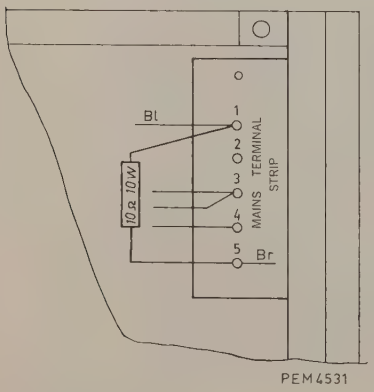


Fig. 4a. Adjusting to a 127 V mains voltage

VI *Operation*

A. KNOBS, SOCKETS AND THEIR FUNCTIONS

Please refer to Fig. 5.

NORMAL TV FRAME	Selects the mode of the triggered operation
TRIGG +/-	Determines whether the sweep is triggered on the positive or negative slope of the triggering waveform
YA-EXT-YB	Selects the triggering signal source
TRIGG	Input for external triggering
STAB.	Controls the stability of the oscilloscope display
⏚	Earthing socket
TIME/div	Controls the time base sweep speeds. Calibrated when the variable control is in position CAL.
POWER ON	Applies or shuts off mains voltage. On-position is indicated by pilot lamp
ILLUM	Adjusts the brightness of the graticule markings in steps
X-MAGN	Provides a five times horizontal expansion of the displayed wave-form
X-SHIFT	Adjusts the horizontal position of the trace
LEVEL AUT.	Determines the point on the triggering wave-form where the sweep is triggered. Can be switched to automatic triggering
X-AMPL.	Input for horizontal deflection by external wave form
CAL. 1V.	Provides the calibrator square-wave

Vertical, both channels

YA, YB	Vertical input for the signal to be displayed
DC BAL	Screwdriver adjustment to balance the amplifier
AC-O-DC	Selects method of coupling the input signal to the vertical amplifier
x1 - x10	Multiplies the gain by a factor 10.
V/div.	Selects vertical deflection factor (variable control must be in CAL position for indicated deflection factor)
Y SHIFT	Controls the vertical position of the trace
INTENS	Controls the brightness of the trace
FOCUS	Provides adjustment for a well-defined display
LA 1...4	Lattice lighting (only one lamp shown)

Controls and sockets on the rear of the instrument (Fig. 4)

TIME BASE (BU7)	Provides sawtooth voltage
⏚ (BU8)	Earthing socket
Z-MOD A (BU9) B (BU10)	Input connectors for intensity modulation of the crt display

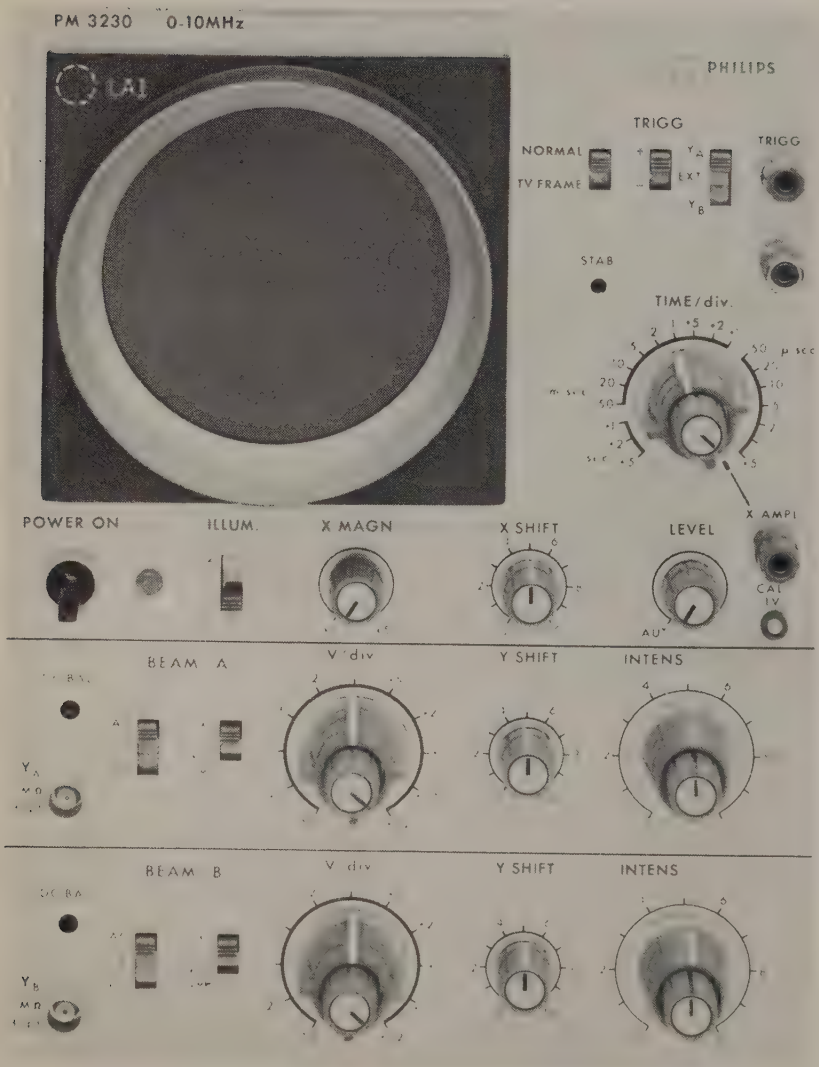
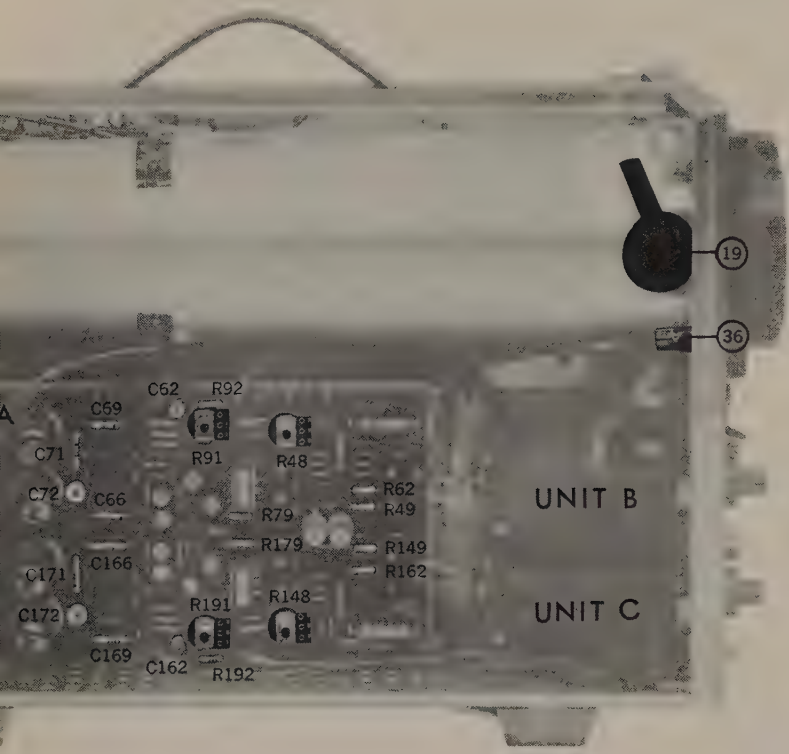


Fig. 5. Controls and sockets

Fig. 6. Side view (left)


19
36
C62
R92
C59
R91
R48
C71
C72
C66
R62
R49
R79
R179
R149
R162
C171
C166
R191
R148
C172
C169
C162
R192
UNIT B
UNIT C

B. MAKING THE TRACES VISIBLE

1. Preliminary settings

a. Adjusting the time-base stability control.

– Set all continuous controls (including "STAB") to their mid-positions
– Set switch "AC-O-DC" to "O"
– Set switch "×1-×10" to "×1"
– Set control "X-MAGN." to "×1".
– Set switch "TIME/div." to "0.5 msec/div."
– Set control „LEVEL" to "AUT."

Both traces should then be visible on the screen centre.
If not:

– Set control "INTENS." to "10".
– Re-adjust one or both "DC BAL." controls until both traces are in the centre of the screen.

With both traces visible:

– Re-adjust the control „INTENS." to prevent damage to the screen.
– Set control "LEVEL" fully anti-clockwise just short of position "AUT.".
– Adjust control "STAB." to the position just anti-clockwise of that at which the trace becomes visible.

The stability is then set and the traces can be made visible again either with the "LEVEL" control adjusted for the signal to be tested or by setting to "AUT.".

b. Adjusting the d.c. balance.

– Make both traces visible on the screen.
– Set both controls "Y SHIFT" to mid-position.
– Set switch "×1-×10" to "×1".
– Set the switch "AC-O-DC" to "O".
– Set switch "V/div." to ".02V/div.".
– Set the traces to the screen centre with "DC BAL.".
– Rotate the continuous attenuator control to and fro between maximum and minimum positions. At the same time adjust the "DC BAL." control until changes in the attenuator continuous control setting no longer cause the trace to be displaced from the screen centre.
– Set switch "×1-×10" to "×10" and readjust.
– Repeat for the other amplifier.

c. Adjusting the vertical gain.

– Set switch "×1-×10" to position "×1".
– Set switch "V/div." to 0.2 V/div. and the continuous control in position "CAL."
– Apply the calibration voltage to socket "YA" ("YB").
– Check that the trace height is 5 divisions. If necessary adjust with R111 (R211). (Fig. 6).
– Set switch "V/div." to 2 V/div.
– Set switch "×1-×10" to "×10".
– Check that the trace height is 5 divisions. If necessary adjust with R91 (R191). (Fig. 6).

d. Adjusting the horizontal gain.

– Set switch "X MAGN." to "×1".
– Set switch "TIME/div." to "X AMPL."
– Apply the calibration voltage to socket "X AMPL."
– Check that the trace height is 5 divisions. If necessary adjust with R91 (Fig. 22.)

2. Input circuit

– The signal to be displayed should be applied to socket "YA", "YB" or both.
If the signal has a large D.C. component, set the input coupling switch to "AC", otherwise the trace may be outside the range of the vertical shift control.
In order to obtain quick location of the zero volts d.c. level the position "O" is provided on the input switch. In this position the amplifier input is disconnected from the input socket and earthed.

C. INTERNAL TRIGGERING (AUTOMATIC)

– Apply the signal to be tested as in B.2 above.
– Set the trigger source selection switch to "YA" or "YB".
– Set the trigger polarity selector to the desired polarity.
– Set the "LEVEL" control to "AUT.".
– Adjust the height of the trace with switch "V/div." and continuous control R7 (the sensitivity is only calibrated when the continuous control is fully clockwise).
– Adjust the sweep-speed with switch "TIME/div." and continuous control R2 to obtain the desired display (the sensitivity is only calibrated whon the continuous control is fully clockwise).
– If desired, the trace can be magnified in the horizontal direction with control "X MAGN.".

D. EXTERNAL TRIGGERING

– Apply an external trigger voltage to socket "TRIGG." and set switch SK3 to "EXT.".
Further, continue as for internal triggering.

E. TRIGGERING WITH MANUAL LEVEL CONTROL

– Set all the controls as for "C" or "D" above.
– Adjust the control "LEVEL" until the time-base starts at the desired level of the input voltage.

F. TV FRAME

– When switch SK1 is at "TV FRAME" the time base can be triggered from the frame pulse of a television signal (except when "LEVEL" is at "AUT.").
For a positive video signal, SK2 should be at "–" and for a negative video signal at "+" (i.e. negative, respectively positive sync. pulse).

G. HORIZONTAL DEFLECTION WITH AN EXTERNAL VOLTAGE

– Set switch "TIME/div." (SK4) fully clockwise.
– Apply an external voltage to socket "X-AMPL." (BU3).
The time-base generator is automatically disconnected and blocked.
– Horizontal amplitude can be varied with control "X MAGN.".

H. BRIGHTNESS MODULATION

– The voltages required for brightness modulation should be applied to sockets "Z-MOD." at the rear of the instrument.

J. PHOTOGRAPHING SCREEN TRACES

For photographing screen traces e.g. with the aid of the Philips photographic equipment PM 9300 consisting of a Rolleicord camera, a Polaroid-Land casette and various adapters for different screen diameters, the exposure table given below can be used as a guide.

For this, pay attention to the following points:

* The table is based on the use of regular rollfilm.
  Experience has proved that, when photographing screen traces, the correct adjustment for Polaroid film corresponds to an adjustment for a relative film speed of a factor 4 lower.

* The table is based on a graticule illumination corresponding to position 2 of SK7 ("ILLUM.").
  If position 1 of SK7 is used, a camera setting should be selected which corresponds to a relative film speed of a factor 4 lower.

Rollfilm — *Graticule illumination: position 2 of SK7*

Film speed		*Relative speed*	*Shutter speed in seconds*							
ASA	DIN		1	1/2	1/4	1/8	1/15	1/30	1/60	1/125
12	12°	1	f=8	f=5.6	f=3.5					
25	15°	2	f=11	f=8	f=5.6	f=3.5				
50	18°	4	f=16	f=11	f=8	f=5.6	f=3.5			
100	21°	8	f=22	f=16	f=11	f=8	f=5.6	f=3.5		
200	24°	16		f=22	f=16	f=11	f=8	f=5.6	f=3.5	
400	27°	32			f=22	f=16	f=11	f=8	f=5.6	f=3.5
800	30°	64				f=22	f=16	f=11	f=8	f=5.6
1600	33°	128					f=22	f=16	f=11	f=8
3200	36°	256						f=22	f=16	f=11
6400	39°	512							f=22	f=16

When photographing screen traces, the following points should always be taken into account:

1. If the measuring graticule is to be photographed along with the trace, the focussing should take place at a point between the trace and the engraved graticule lines (graticule with its engraved side against the cathode-ray tube).
   Preferably select an aperture setting of $\geqslant 8$, so that sufficient depth of field is obtained.
   After adjusting the trace to the desired brightness with the knob "INTENS.", adapt the graticule illumination with SK7 ("ILLUM.").
   The double-exposure technique can be successfully employed, at which first the trace is photographed only and then the measuring graticule only:

a. if an aperture setting of $\geqslant 8$ cannot be used,
   b. if difficulties arise with adaptation of the light intensity of screen trace and measuring graticule, e.g. when photographing non-recurrent phenomena.

2. Select such a shutter speed that the trace is displayed 3 to 4 times during the exposure time.
   This will result in a photograph of uniform brightness.

3. Always remove the contrast filter.

4. Before every exposure, always ensure that there is no incidental external light which may cause reflections on the screen.

SERVICE DATA

VII *Circuit description*

A. Y-AMPLIFIER (Fig. 28)

The oscilliscope has two identical vertical amplifiers and therefore, for the sake of clarity, only the one for beam A is described. However, the corresponding elements for the other beam are given in brackets.

Input stage (unit A in Fig. 7)

To obtain a high input impedance of the amplifier, a source-follower stage TS32 (TS132) has been used.
The d.c. drift of the amplifier has been reduced by source follower TS33 (TS133) because variations in the d.c. levels on the sources of TS32 (TS132) and TS33 (TS133) neutralise each other.
The d.c. voltage on the gate of TS33 (TS133), which is adjustable with R6 (R12) "DC BAL", serves to equalise the emitter d.c. voltages of TS26′ and TS26″ (TS126′ and TS126″) when no input signal is connected. Now there will not be a d.c. voltage, across the continuous amplification control R7 (R13), with the result that shifting of the trace across the screen is prevented, when R7 (R13) is turned.

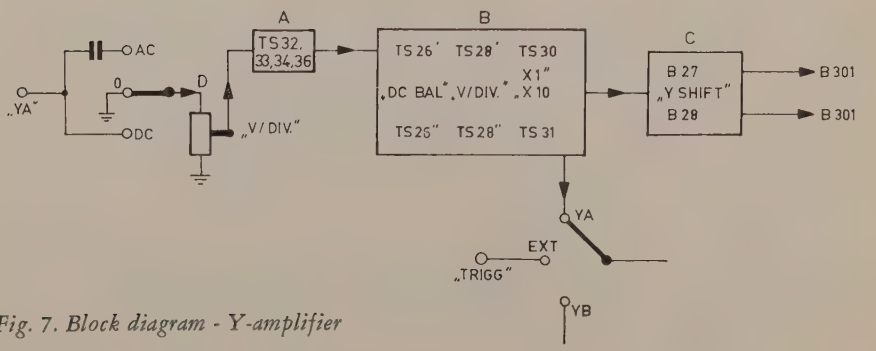


Fig. 7. Block diagram - Y-amplifier

Pre-amplifier (unit B in Fig. 7)

A phase-inverter TS26′-26″ (TS126′-126″) is asymmetrically driven at the base of TS26′ (126′) from transistor TS34 (TS134).
Similar but counter-phased voltages which arise on the collectors of these transistors are variable in magnitude with continuous attenuator R7 (13) "V/div.".
The balanced amplifier TS28′-28″ (TS128′-128″) is driven symmetrically from the collectors of TS26′-26″ (TS126′-126″).
Switch SK10 (13) "×1–×10", which is included in the emitter circuit of this stage, serves to switch potentiometer R91 (191) on or off so that the amplification of this stage may be increased by a factor 10.
Coupling to the output stage is effected via emitter followers TS30 (130) and TS31 (131) which reduce the effect of the high input capacitances of the output stage on the balanced amplifier.

Output stage (unit C in Fig. 7)

The balanced amplifier B27″-B28′ (127″-128′) is driven symmetrically and the d.c. levels at the control grids are variable by means of potentiometer R8/R9 (14/15) thus providing vertical shift control.
The amplification of the stage is so adjusted with R111 (211) that with SK10 (13) open the deflection sensitivity of the vertical amplifier is 20 mV/div.
When SK10 (13) is closed however, the sensitivity is 2 mV/div.; this can be accurately adjusted by means of R91 (191).
The output stage is coupled to the deflection plates of the cathode-ray tube via cathode followers B27′-B28″ (127′-128″) which reduce the effect of the deflection plate capacitance on the anode circuits of B27″ and B28′ (127″-128′).
The bandwidth of the amplifier is corrected for high frequencies by means of capacitors C72 (172), C71 (171), C62 (162) and for relatively low frequencies by means of capacitors C66 (166) and C69 (169).
The trigger signal is taken from the emitter of TS30 (130) in phase to the input signal on socket "YA (YB)".

Attenuator (unit D in Fig. 7)

The attenuator consists of five sections which are so interconnected with switch SK11 (14) "V/div." that a total of 14 different sensitivities is obtained, i.e.

Section	*Resistors*	*Attenuation*
A	R27-31 (127-131)	1 : 10
B	R28-32 (128-132)	1 : 100
C	R29-33 (129-133)	1 : 1000
D	R36-38 (136-138)	1 : 2.5
E	R37-39 (137-139)	1 : 5

If section C is connected in series with section D the sensitivity is likewise 50 V/div.

Section C by itself provides a sensitivity of 20 V/div.

Thus sensitivities from 50 V/div. to 0.02 V/div. can be obtained. By means of switch SK10 (13) the sensitivity in every position is increased by ten times, resulting in three additional different sensitivities, i.e. 0.01–0.005 and 0.002 V/div.

Frequency compensation of the sections is carried out by correct adjustment of trimmers C34 (134), C36 (136), C37 (137), C47 (147), C48 (148), C42 (142) and C43 (143).

When an attenuator probe is used, the input capacitance of the amplifier at the "YA" (YB) socket should be the same in all positions of the attenuator switch. This is ensured by correct adjustment of trimmers C31 (131), C32 (132) and C33 (133).

When switch SK9 (12) is in position "AC", the input signal is fed to the amplifier via a blocking capacitor C26 (126) and is fed directly in position "DC".

In position "O" the input socket is disconnected and the amplifier input is connected to earth so that d.c. balancing can be effected.

B. TRIGGER-PULSE SHAPER (Fig. 30)

Amplifier stage (unit A in Fig. 8)

The trigger signal from the Y-amplifier A, B or an external source on socket "TRIG." is fed to the amplifier stage TS501-TS502 which consists of an emitter-coupled balanced amplifier.

If the trigger signal is present on the base of TS501, the collector signal of TS501 and TS502 are of equal amplitude but in anti-phase.

Switch SK2 "+–" enables triggering on the negative or positive-going edge of the signal.

The direct voltage on the base of TS502 is continuously adjustable with control R5 "LEVEL". This adjustment determines the point on the trigger signal at which the time-base generator starts.

Schmitt-trigger circuit (unit B in Fig. 8)

If switch SK1 is at "NORMAL" the trigger signal passes directly to the Schmitt-trigger TS503-504 (SK8 is closed).

Thus with a repetitive trigger signal, a square-wave of constant amplitude arises on the collector of TS504.

This square-wave is differentiated by C508 and R523 into narrow positive and negative pulses.

The positive pulses are suppressed by GR501 so that the time-base generator receives only negative pulses.

If SK8 is at "AUT.", C504 is connected to the base circuit of TS503 and the circuit acts as an astable multivibrator. Thus the time-base generator starts even if no trigger signal is fed to the pulse shaper.

If a trigger signal is connected to the input of the pulse shaper, the astable multivibrator is synchronised with this signal and the pulses are at the frequency of the connected voltage.

In the position "AUT." the wiper of R5 is at junction R5-R511.

To ensure that the base potential of TS502 remains the same when R5 is in the mid position and in position "AUT.", resistor R510 is switched off by SK8a in the latter position of R5.

Synchronisation separator (unit C in Fig. 8)

The separator circuit enables triggering from the frame pulse of a television signal.

Transistor TS509 is driven so that it conducts only for the peaks of the synchronising pulses.

For a positive video signal, switch SK2 should be set to "–" and for a negative video signal to "+".

The frame synchronising pulses are separated from the line synchronising pulses by means of integrating network R534-C513.

The integrated frame pulses then trigger Schmitt-trigger TS503-504.

C. TIME-BASE GENERATOR AND X-AMPLIFIER (Fig. 30)

Schmitt-trigger (unit A in Fig. 9)

Starting from the condition TS505 cut-off and TS506 conducting, diode GR502 conducts and cuts-off transistor TS512.

When a negative pulse arises on the base of TS505, the latter conducts and the circuit switches over. Diode GR502 cuts-off and transistor TS512 becomes conductive.

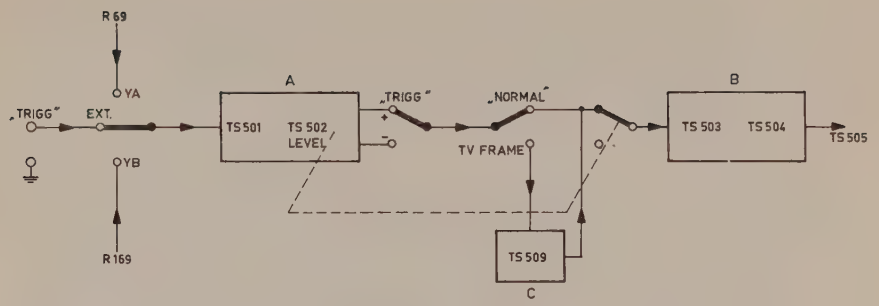


Fig. 8. Block diagram - trigger pulse shaper

Bootstrap-integrator (unit B in Fig. 9)

When the Bootstrap-integrator transistor TS512 conducts, the time-base capacitor(s) (C521-C529) is (are) charged. A linearly rising voltage appears across the timing capacitor and is fed back to the Schmitt-trigger (TS505) via emitter-follower TS513, phase-inverter TS514 and emitter-follower TS515.

When this voltage reaches a certain level the Schmitt-trigger switches over again and the Bootstrap-integrator is cut-off until the following trigger pulse appears.

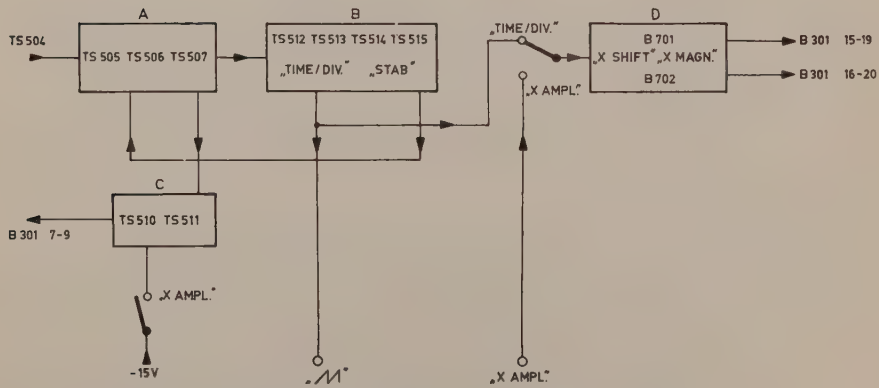


Fig. 9. Block diagram - time-base generator and X-amplifier

The stability of the time-base generator can be adjusted with potentiometer R1 "STAB." which determines the d.c. voltage level on the base TS505 which is so arranged that the negative-going pulse present at the end of the flyback does not switch-over the Schmitt-trigger.
Potentiometer R569 determines the length of the time-base line. A "hold-off" circuit is connected in the feedback circuit to the multivibrator.
This ensures that the time-base capacitors can discharge fully after the sweep, so that the start of the sawtooth always occurs at the same level. Nineteen different sweep speeds can be selected with switch SK4 "TIME/div.". These speeds are obtained with 8 different capacitors (C521-C529) and 3 different resistors (R552-554).
Continuous variation of sweep speeds between steps of SK4 is possible with potentiometer R2 "TIME/div.". If R2 is turned fully clockwise, it is short-circuited by switch SK5 and the sweep speeds are at the calibrated values, final adjustment being carried out with R550. The fastest calibrated sweep speed is accurately adjusted by means of C530.
The output sawtooth waveform is taken off from the emitter of TS513 and fed to the horizontal amplifier via switch SK4. An external output signal is available on socket BU7.

Beam deflection (unit C in Fig. 9)

During the flyback of the sawtooth voltage, a voltage is fed to the cathode-ray tube which causes the electron beam to be deflected outside the screen edges.
The required voltage is delivered by a bi-stable multivibrator (TS510-511) which is triggered by a positive pulse on the emitter of TS507, which occurs during flyback.
When the multivibrator switches, the beam deflection takes place and ceases when a negative pulse appears on the emitter of TS507 at the start of the sweep.

External control of the horizontal amplifier

In the extreme right-hand position of SK4 "X AMPL." the connection between the time-base generator and the horizontal amplifier is interrupted. The external signal is supplied via socket BU3. The time-base generator is sumultaneously switched off by changing potential on the base of TS505 due to the connection of the –15 V line to R557 via SK4.I.

Furthermore, a voltage of –15 V is fed to the base of TS510 so that the beam deflection multivibrator, with external horizontal drive, remains in the condition TS510 off - TS511 on, thus ensuring brightness control.

X-amplifier (unit D in Fig. 9)

This stage consists of a balanced amplifier using valves B701-B702. Sensitivity can be adjusted with control R3 "X MAGN.". Horizontal shift is effected with control R4 "X SHIFT".

The time-base voltage or external voltage is fed to the control grid of valve B701. In both cases the d.c. level corresponds to earthing potential. The signals are cross-coupled to the deflection systems of the cathode-ray tube from the anodes of B701 and B702.

The sensitivity of both deflection systems is matched by means of potentiometers R705 and R717. R720 and R707 provide preset gain control.

D. CATHODE-RAY TUBE CIRCUIT (Fig. 32)

Brightness can be adjusted for each system with controls R10 and R16 "INTENS.", respectively.

Focussing is effected with controls R11 and R17 "FOCUS" while correction for astigmatism is possible with R303 and R323.

Barrel and pin-cushion distortion can be corrected with R302 and the relative shift of the traces in the horizontal direction due to differences in the deflection systems can be reduced by means of R301.

Brightness modulation facilities are provided on sockets BU9 and 10. Graticule illumination is switchable in two steps with SK7 "ILLUM." (see power-supply diagram, Fig. 34).

E. POWER SUPPLY (Fig. 34)

–15 V

The alternating voltage across windings S12+S5 is full-wave rectified and electronically stabilised.

This is effected by comparing a voltage, proportional to the output voltage, via a difference amplifier TS1003-1004, with a reference voltage (GR1007).

R1016 provides precision setting of the output voltage.

Ripple voltage present on the output is fed back via C1009.

R1013 provides control of this feedback.

–85 V

The alternating voltage on winding S4 in parallel with S11 is full-wave rectified and smoothed.

+95 V and +180 V

The alternating voltage across S3+S10 is full-wave rectified and electronically stabilised (+95 V).
Valve B1002 provides the reference voltage.
Ripple is fed back via C1003 and can be set to a minimum with R1002.
The +180 V is available after smoothing circuit R1004-C1004.

F. HIGH-VOLTAGE UNIT (Fig. 32)

The high-voltage supply is generated by means of a relaxation oscillator. This consists of transistors TS1006 and TS1007 in conjunction with coil S3-S3′.
The frequency of oscillation is 8 kHz.
After voltage doubling, a voltage of +3200 V appears across C1026. A portion of the secondary voltage is half wave rectified and appears across C1028 (–900 V).
This unit also provides the calibration voltage. The primary square-wave voltage from the oscillator is fed to a Zener diode GR1011 which stabilises the voltage.
Resistor R1034 is so selected that the output voltage is 1 V_{p-p}.

VIII *Gaining access to components*

Caution!

Very high voltages are generated in this instrument, so that when effecting work to the inside of the instument great care must be taken.

A. REMOVING THE SIDE PANELS

The instrument has one plate on each side, each fixed with two fasteners Loosen these fasteners and remove the panels from the frame.

B. REMOVING THE KNOBS (see Fig. 10)

Single knobs

- Remove cap "A".
- Loosen screw "B".
- Pull the knob off the spindle.

Double knobs

- Remove cap "A".
- Remove screw "B".
- Remove the inner knob.
- Loosen nut "C".
- Pull the outer knob off the spindle.

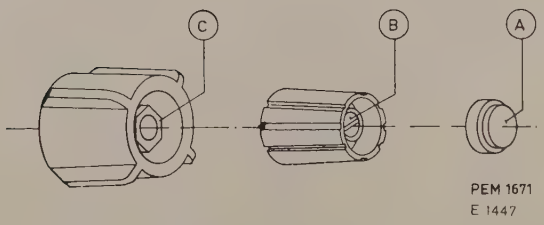


Fig. 10. Removing knobs

C. REMOVING THE PROTECTIVE CAP AND LATTICE (see Fig. 11)

– Grip the cap as shown in Fig. 11 and pull back the lower part.
– The protective cap, measuring lattice and contrast material can then be removed.

D. ACCESS TO THE HIGH-VOLTAGE UNIT (see Fig. 24)

– Place the instrument on its side.
– Slide out the small bottom plate.
The high-voltage unit can then be slid out for servicing (take care not to damage the connection wires) so that measurements may be carried out while the instrument is working.

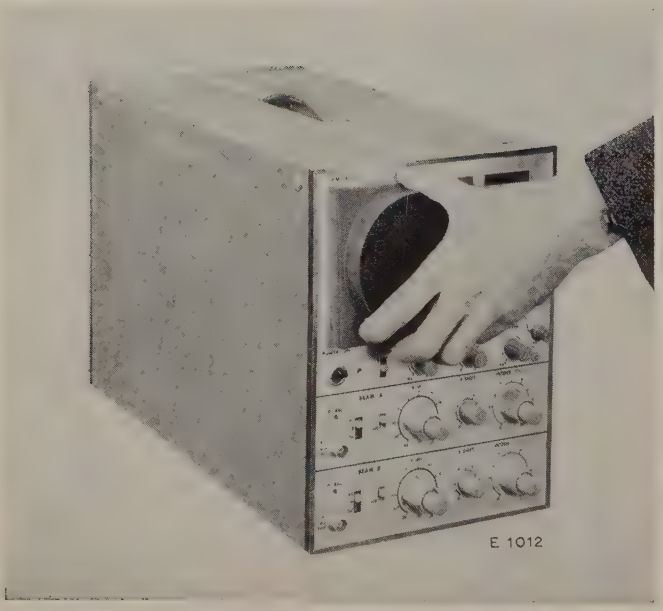


Fig. 11. Removing protective cap and measuring graticule

IX *Adjusting elements and their functions*

The order given below is arbitrary. For the complete adjusting procedure please refer to chapter "Checking and adjusting".

Adjustment	*Element*	*Fig.*	*Auxiliary equipment*	*Philips type*	*Chapter X, section*
Vertical amplifiers:					
d.c. balance	R48 (R148)	6	—	—	D
	R74 (R174)	26			
	R71 (R171)	26			
Sensitivity	R91 (R191)	6	sine-wave generator	PM5120	
	R111 (R211)	6			
Square-wave response attenuators	C34 (C134)	12	square-wave generator	PM5710	
	C36 (C136)	12			
	C42 (C142)	12			
	C43 (C143)	12			
	C47 (C147)	12			
	C48 (C148)	12			
Square-wave response amplifier	C62 (C162)	6	square-wave generator	PM5710	
	C66 (C166)	6			
	C69 (C169)	6			
	C71 (C171)	6			
	C72 (C172)	6			
	R92 (R192)	6			
Square-wave response via attenuator probe	C31 (C131)	12	square-wave generator	PM5710	
	C32 (C132)	12			
	C33 (C133)	12	sine-wave generator	PM5120	
deflection and shift	R79 (R179)	6			
Calibration voltage	R1033; R1034; R1036	24	—	—	E F
Horizontal amplifier:					
Sensitivity	R707; R715;	22	sine-wave generator	PM5120	
bandwidth	R720		sine-wave generator	PM5120	

Adjustment	*Element*	*Fig.*	*Auxiliary equipment*	*Philips type*	*Chapter X, section*
Time-base generator:					G
Stability	R547; R564	22	—	—	
Sweep speeds	C530; R542	22	sine-wave generator	PM5120	
	R550; R569	22	variable transformer	E401AB/010	
Shift	R 713	22	—	—	
Power supply:					B
— 15 V amplitude	R1014; R1016	22	d. c. voltmeter	PM2401	
ripple	R1013	22	variable transformer	E401AB/010	
+ 95 V amplitude	R1010	22	oscilloscope	PM3221	
ripple	R1002	22			
C.R.T.:					C
Intensity	R307 (R327)	22	—	—	
	R309 (R329)	22			
Focus and astigm.	R303 (R323)	22	—	—	
	R306 (R326)	22			
distortion	R302	22	—	—	
horizontal	R301	22	—	—	
deflection	R705	22			
correction	R717	22			

X *Checking and adjusting*

A. GENERAL INFORMATION

All adjustable elements, their functions and location are listed in the table "Adjusting elements and their functions" (chapter IX).
The tolerances mentioned in the following text apply only for newly adjusted apparatuses. The values may differ from those given in Chapter II.

B. POWER SUPPLY

Mains current

– Check that the mains current at 220 V, 50 Hz is $\leqslant$ 450 mA.
(Measured with a moving iron meter)

–15 V

– Check that the voltage is –15 V for a nominal mains voltage of 220 V. If necessary, adjust with R1016, or select a different value for R1014. The –15 V should not vary more than 100 mV for a $\pm$ 15 % mains voltage variation.
– Check that the ripple voltage is not higher than 15 mV_{p-p}. If necessary adjust to a minimum with R1013.

+95 V

– Check that the voltage is +95 V $\pm$ 1 V for a nominal mains voltage of 220 V.
If necessary select a different value for R1010.
The +95 V should not vary more than 300 mV for a $\pm$ 15 % mains voltage variation.
– Check that the ripple voltage does not exceed 50 mV_{p-p}. If necessary, adjust to a minimum with R1002.

–85 V and + 180 V

– Check that the voltage across C1007, at a nominal mains voltage of 220 V, meets the following requirements:
–85 V $\pm$ 5 V.
ripple $\leqslant$ 1 V_{p-p}.
– Check that the voltage across C1004, at a nominal mains voltage of 220 V, meets the following requirements:
+180 V $\pm$ 10 V.
ripple $\leqslant$ 1.5 V_{p-p}.

E.H.T.

- Check that the voltage across C1026 lies between +2900 and +3500 V and that, for a mains voltage variation of ± 15 % the maximum voltage variation is 10 V.
- Check that the voltage across C1028 lies between –880 V and –1000 V and that the ripple does not exceed 500 mV_{p-p} for a mains voltage variation of ± 15 % (R10 and R16 „INTENS" counter-clockwise).

C. CATHODE-RAY TUBE CIRCUIT

Intensity

Beam A

- Set „LEVEL" to position „AUT.".
- Set „TIME/div." to position „1 msec./div.".
- Set „INTENS" (B) anti-clockwise.
- Check if the brightness decreases evenly when turning the control "INTENS." (A) anti-clockwise.
  Check also if the trace becomes just visible at setting 3 of control „INTENS.". If required select a different value for R309.
- Turn „INTENS." completely clockwise and check if consequently a trace enlargement takes place of max. 0.2 divisions.
  If required, select such a value for R307 that the above requirement is met and repeat both adjustments.

Beam B

- As for beam A but read R327 and R329 for R307 and R309 and "INTENS" (A) for "INTENS" (B).

Picture distortion

- Set "TIME/div." to position "1msec/div.".
  "AC-O-DC" (A and B) in position "DC".
  "YA-EXT-YB" in position „YA".
- Check that the trace of channel A is well defined at normal brightness. If necessary, adjust with "FOCUS" (A) and R303 (astigmatism).
- Check that the trace runs horizontally. If necessary, set the C.R.T. to the correct position with the aid of lever "A" (Fig. 6).
- Apply signals having the same phase and a frequency of 20 kHz to sockets "YA" and „YB".
  Adjust to a picture height of eight divisions, symmetrically with respect to the centre of the screen.

- With the aid of R569, adjust to a picture width of approximately eight divisions.
- Check that the pictures are well defined at normal brightness. If necessary, adjust with "FOCUS" (A) and R303 or "FOCUS" (B) and R323 respectively.
- Reduce the barrel and cushion distortion to minumum with the aid of R302 (readjust focusing). If necessary, determine an average setting for channels A and B.
- Next, make the top and bottom of the envelopes of both pictures run in parallel with the aid of R301. If necessary, determine an average setting for the top and bottom.
- Repeat the above check.
- Set TIME/div. to position "20 μsec/div.".
- At maximum brightness check that with "FOCUS" (A and B), control through the focussing point can be obtained. If necessary, select a lower value for R306 or R326 respectively. Also check that at maximum brightness focussing at scale divisions 3 or higher is possible.
- Reduce the picture height for both channels to six divisions.
- Select such a time coefficient that six periods are displayed.
- Make the pictures coincide as well as possible with the aid of knobs "Y SHIFT" and the continuous attenuators.
- Check that the centre four periods of both pictures coincide. (A small deviation may occur at the tops.)
- If necessary, adjust with R705 and R717. If the four periods do not coincide in the centre of the screen, also include R301 in the adjustment. However in this case repeat the adjustments with R302, R705 and R717 and check that the angle between the envelopes does not exceed 1.5°.
- Check that the trace of channel A runs horizontally. If necessary, set the C.R.T. to the correct position with the aid of lever "A" (Fig. 6).

D. VERTICAL AMPLIFIER

Both amplifiers are identical and therefore the procedure and adjustments required are also identical. The controls and sockets applicable for the B amplifier are given in brackets after those applicable for amplifier A.

Balance

a. – Set "AC-O-DC" A (B) to position "O".
– Set "×1-×10" A (B) to position "×1".
– Set "V/div." A (B) to position "20 mV/div.".
– Set "LEVEL" to position "AUT.".

- Set "DC-BAL" A (B) to its mid-position.
- Turn "V/div." A (B) (continuous control) fully anti-clockwise.
- Set "Y SHIFT" A (B) to its mid-position.
- Adjust R48 (R148) so that the trace does not shift, when "V/div." A (B) (continuous control) is turned.
- Turn "V/div." A (B) (continuous control) fully anti-clockwise.
- Check that with "DC-BAL" A (B) the trace can be displaced from the point of balance over at least 1.5 div. towards the top and bottom of the screen.
- Readjust the balance with "DC-BAL" A (B).

b.
- Set "×1-×10" A (B) to position "×10" and readjust the balance. If necessary the trace can be kept in the centre of the screen with "Y-SHIFT" A (B).
- Set "×1-×10" A (B) to position "×1". The trace should not jump more than 1.2 div. (1.5 div. at final check). If necessary select a different value for R74 (R174) or R71 (R171); after this readjust "DC-BAL" A (B) and repeat point *a.*
- Set "AC-O-DC" A (B) to position "DC".
- Short-circuit socket "YA" ("YB") against earth. The trace should not jump more than 0.25 div.

Sensitivity

- Set "AC-O-DC" A (B) to "DC".
  Set "V/div." (continuous control) A (B) to "CAL".
- Set "V/div." A (B) to "20 mV/div.".
- Set "×1-×10" A (B) to "×1".
- Apply a voltage of exactly 160 mV_{p-p}, 2 kHz to socket "YA" ("YB").
- Check that the trace height is 8 divisions.
  If necessary adjust with R111 (R211) to exactly 8 divisions. After adjusting R111 (R211) should still have some control reserve left.
  Tolerance at final check: ± 3 %; if necessary readjust R111 (R211).
- Check that for a ± 15 % mains voltage variation the trace height does not change more than 3.5 % and that the trace does not shift more than 1 division in vertical direction.
- Set "×1-×10" A (B) to "×10".
- Apply a voltage of exactly 16 mV_{p-p}, 2 kHz to socket "YA" ("YB").
- Check that the trace height is 8 divisions.
  If necessary adjust with R91 (R191) to exactly 8 divisions. After

adjusting R91 (R191) should still have some control reserve left.
Tolerance at final check: ± 3 %; if necessary readjust R91 (R191).

- Check the deflection factors in all positions of "V/div." A (B) and "×1-×10" A (B) and check that deflection is 8 divisions ± 3 % at 2 kHz.
- Check that the control of "V/div" A (B) (continuous control) is 1 : 2.6 to 1 : 6.

Hum

- Set "V/div." A (B) to "20 mV/div.".
  Set "×1-×10" A (B) to "×10".
- Check that the hum, with open circuit input does not exceed 0.2 division (with side panels fitted in place).

Square-wave response

- Set "AC-O-DC" A (B) to "DC",
  Set "V/div." A (B) to "20 mV/div.",
  Set "×1-×10" A (B) to "×1",
  Set "V/div." (continuous control A (B) to "CAL".
- Apply a square-wave voltage of 80 mV_{p-p} 500 kHz to socket "YA" ("YB") and check that no overshoot occurs.
  If necessary, adjust with C72 (C172) and C62 (C162) or select a different value for C71 (C171).
- Lower the frequency of the square-wave voltage to 2 kHz and check that no overshoot occurs.
  If necessary, select different values for C66 and C69 (C166 and C169).
- Apply a square-wave voltage of 2 kHz and sufficient amplitude to obtain a trace height of 8 divisions and check that no overshoot occurs in any of the positions of the attenuator A (B). (Side panels fitted.)
  If necessary, adjust to the following table:

Attenuator	*Adjusting element*
50 mV/div.	C47 (C147)
100 mV/div.	C48 (C148)
200 mV/div.	C34 (C134)
500 mV/div.	C42 (C142)
1 V/div.	C43 (C143)
2 V/div.	C36 (C136)
20 V/div.	C37 (C137)

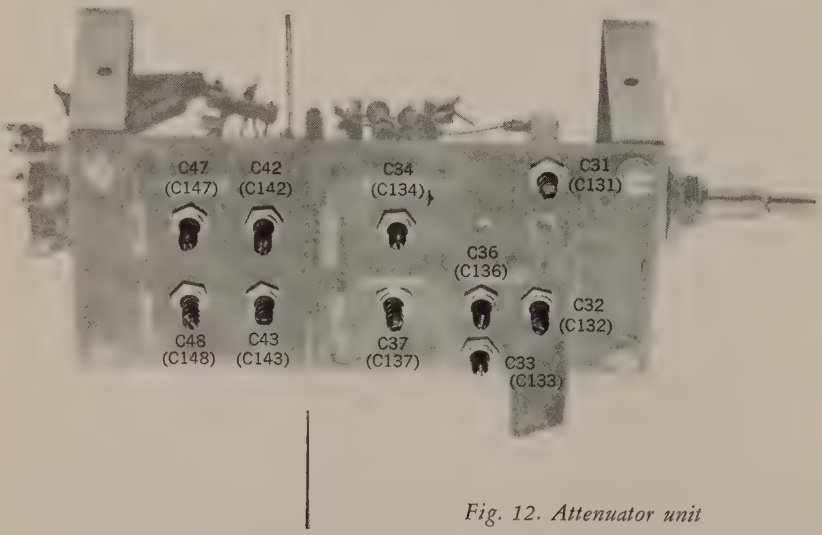


Fig. 12. Attenuator unit

- Check the square-wave response in position "2 mV/div." (20 mV/div. - ×10) at a trace height of 8 divisions. If necessary select a different value for R92 (R192).
- Check the square-wave response in the other attenuator positions i.e. 5-10-20 mV/div. and 5-10-50 V/div., at a trace height of 8 divisions.
- Connect an attenuator probe 1 : 10 to "YA" ("YB").
- Set "V/div." A (B) to "20 mV/div."
  Set "×1-×10" A (B) to "×1".
- Apply a square-wave voltage of 1.6 V_{p-p}, 2 kHz to the probe and check the response of the probe (permissible overshoot 2 %). If necessary adjust the capacitor in the probe (see chapter XIII. B2).

– Check the attenuation of the probe: it should be × 10 ± 2.5 %.
  Then check the square-wave response via the probe with the attenuator at "200 mV/div.", "2 V/div." and "20 V/div.", and switch "×1-×10" to "×10" (trace-height 8 divisions).
  If necessary adjust trimmers C31 (C131), C32 (C132) and C33 (C133) respectively.
– Set switch "×1-×10" to "×1".
– Check that the square-wave response in the positions "50 mV/div." and "100 mV/div." is at least as good as in Fig. 14.

Bandwidth

– Set "V/div." A (B) to "20 mV/div." and "×1-×10" A (B) successively to positions "×1" and "×10".
– Check that the bandwidth, at a trace height of 8 divisions meets the following requirements:

"×1"	"×10"
2 kHz = 100 %	2 kHz = 100 %
10 MHz ⩾ 70 %	2 MHz ⩾ 70 %

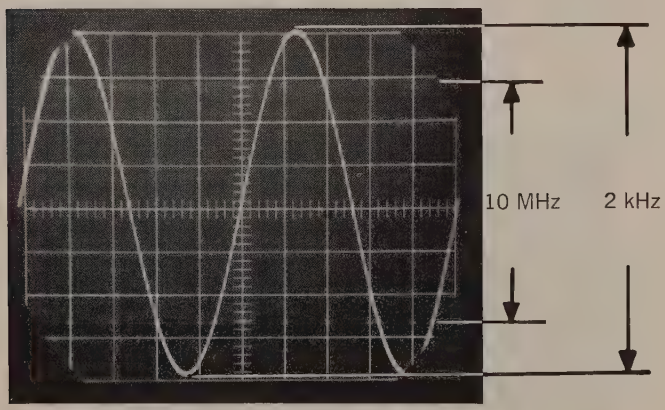


Fig. 13. Band width

– If necessary, re-check the square-wave reproduction.
– In position "AC" of "AC-O-DC" A (B), check that a d.c. voltage connected to socket "YA" ("YB") is blocked by capacitor C26 (C126).

Deflection and shift

- Set "V/div." A (B) to "20 mV/div.",
  Set "×1-×10" A (B) to "×1",
  Set "V/div." (continous control) A (B) to "CAL.".
- Apply a sine wave voltage of 480 mV_{p-p}, 100 kHz to socket "YA" ("YB").
- Check that the undistorted peaks can be made visible within the screen by the "Y SHIFT" A (B) control.
- If necessary, select a different value for R79 (R179).
- Apply a voltage of 10 MHz with sufficient amplitude to obtain a trace height of 3 divisions.
- Double the input voltage amplitude and check that the deflection is 6 divisions ± 0.5 division.
  If necessary, re-check the square-wave and frequency response of the amplifier.

Microphony

- Set "AC-O-DC" A (B) to "O"
- Set "V/div." A (B) to "20 mV/div.",
  Set "×1-×10" A (B) to "×10".
- Check that when switch "TIME/div." is turned any resulting microphony does not exceed 1 division of the deflection of the trace.

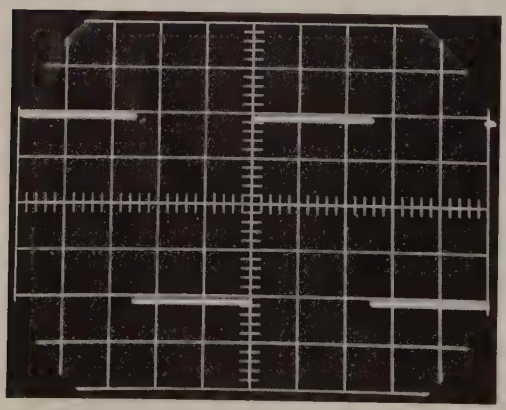


Fig. 14. Square-wave vesponse via probe at 2 kc/s

E. CALIBRATION VOLTAGE (carry out this check when the instrument has attained operating temperature)

- Set "AC-O-DC" to "DC",
  Set "V/div." to "200 mV/div."
  Set "V/div." (continuous control) to "CAL.".
- Connect socket "CAL. 1 V" to "YA" and check that the trace height is 5 divisions.
  If necessary, select a different value for R1034 to obtain an accuracy of 1 %, and if further adjustment is necessary, replace R1033 and R1036.
- Check that the frequency of the calibration voltage is 8 kHz $\pm$ 1 kHz.

F. HORIZONTAL AMPLIFIER

Sensitivity

- Set "X MAGN." to "CAL.".
- Apply a signal of 4 V_{p-p}, 2 kHz to socket "X AMPL.".
- Check that the trace width is 8 divisions $\pm$ 1 % (symmetrical about screen centre).
  If necessary, adjust with R720 or select a different value for R707.
- Check that the control range of "X MAGN." is 1 : 5 $\pm$ 10 %.
- If necessary select a different value for R715.

Bandwidth

- Set "X-MAGN." to "CAL.".
- Check that the bandwith with an input sufficient for a deflection of 4 divisions meets the following requirement:
  2 kHz = 100 %
  1 MHz $\geqslant$ 70 %
  If necessary, select a different value for C702.

G. TIME-BASE GENERATOR

Stability

- Set switch "TRIGG +/–" to position "+".
- Set switch "AC-O-DC" to position "O".
- Set control "LEVEL" to minimum (not "AUT.").
- Set switch "TIME/div." to "0.5 msec/div.".
- Set control "STAB" fully anti-clockwise.

- Turn control "STAB." clockwise to the point at which the time-base just runs free (i.e. line on screen) and note the position of the control.
- Continue turning the control clockwise (the time-base should remain in its free running position; if necessary select a different value for R564) until a bright spot appears at the start of the trace or until the time base cuts out at the fully clockwise position of "STAB." Observe the position again.
- The difference between the positions of the screwdriver slot in the potentiometer shaft for these two settings should correspond to an angle of at least 30°.

  If necessary select a different value for resistor R547.
- Set switch "AC-O-DC" to position "DC".
- Set knob "LEVEL" to position "AUT.".
- Set switch "TIME/div." to position "0.5 μsec/div."
- Apply a 1-MHz signal to socket "YA" and adjust the trace height to ½ division.
- Adjust for a triggered trace with "STAB".
- The angle between this setting of potentiometer "STAB." and the extreme counter-clockwise setting should be at least 30°.

Triggering

Internal "A"

- Apply a 2-kHz sine-wave voltage to socket "YA" and adjust the attenuator for a trace of 0.5 division high.
- Adjust the "LEVEL" control to trigger on this signal.
- Change the frequency successively to 10 Hz and 2 MHz and check that the trace remains stationary when it is 0.5 divisions high at both frequencies.
- Set "TRIGG." to "—" and check that triggering takes place on the negative edge. (If necessary, readjust control "LEVEL").
- At 10 Hz and 2 MHz check that correct triggering takes place when the trace height is continuously increased to 8 divisions.
- Check that the trigger-level can be varied over 7 divisions at 2 kHz with control "LEVEL".
- If necessary, adjust the symmetry of the level control adjustment with R510.
- Check that the time-base generator cuts out at a trace height of 8 divisions with control "LEVEL" fully anti-clockwise or fully clockwise (not in position „AUT.").

– Check that the time-base generator does not cut out at a trace height of 15 divisions with control "LEVEL" fully clockwise or fully counter-clockwise (not in position "AUT.").
– Check that when "TIME/div." (continuous control) is varied no double trace occurs.

Internal "B"

– Set "YA-EXT-YB" to "YB."
Set "TIME/div." (continuous control) to "CAL.".
– Apply a sine-wave voltage of 10 Hz respectively 2 MHz to socket "YB" and check that the trace can be made stationary with control "LEVEL" for a trace height of 0.5 division.

External

– Set "YA-EXT-YB" to "EXT.".
– Apply a sine-wave voltage of 0.9 V_{p-p} to socket "TRIGG." derived from the same voltage source as that connected to socket "YA" and check that the time-base generator triggers at 10 Hz and 2 MHz.

Automatic

– Set "YA-EXT-YB" to "YA",
Set "LEVEL" to "AUT.",
Set "TIME/div." to "2 msec/div",
– Check that the time-base line is displayed on the screen without an input signal being present.
– Apply a 20 Hz respectively 1-MHz sine-wave voltage to socket "YA" and check that the trace is stationary at a trace height of 0.5 divisions.

T.V. Frame

– Set "NORMAL-TV FRAME" to "T.V. FRAME".
Set "TRIGG" to "—".
– Apply a positive video signal to socket "YA". (French system: frame sync. is 0.4 of the line time).
– Check that at a trace height of 0.5 div. (sync. signal) the triggering can be adjusted with control "LEVEL" to trigger from the frame pulse.

Sweep speeds

– Set "X-MAGN." to position "CAL."
"NORMAL - TV FRAME" to position "NORMAL"
"TIME/div." to position "0.1 msec/div."
Continuous control "TIME/div." to position "CAL."

"YA-EXT.-YB" to "YA".
- Apply a 10-kHz voltage to socket "YA".
- Adjust for a triggered image with "LEVEL".
- Check if the trace width is 10 divisions. If not, adjust for 10 divisions with R569.
- Check if there are 8 periods on 8 divisions. If not, correct with R550.
- Next, check the sweep speed 0.2 msec/div. Tolerance 1 %.
  If necessary, determine an average setting for sweep speed 0.1 msec/div. and 0.2 msec/div. by means of R550.
- Next, set TIME/div." to position "50 µsec/div.".
- Adjust the input voltage frequency to 20 kHz.
- Check if there are 8 periods on 8 divisions. Tolerance ± 1 %.
  If required, adjust the sweep speed as nominally as possible with R542.
- Check the sweep speed in position "0.5 µsec/div.".
- If required, select a different value for C530.
- Check that a ± 15 % mains-voltage variation does not create a deviation of the sweep speeds, which exceeds 4 %.
- Next, check the sweep speed over 8 divisions in all positions of switch "TIME/div.".
  Tolerance ± 3 %, with exception of the sweep speed 0.5 sec/div. of which the tolerance is ± 4 %.
- Check that the length of the time-base line in all positions of switch "TIME/div." is more than 9 divisions.
- Check that the control range of the continuous control "TIME/div." in the "2 msec/div." setting is 1 : 2.5 to 1 : 3.

Magnification, shift and linearity
- Set "X MAGN." to "CAL.",
- Set „TIME/div." (continuous control) to "CAL.",
  Set „TIME/div." to "50 µs/div.".
- Apply a 20 kHz signal to socket "YA".
- Set "X MAGN." to "×5".
- Check that the time base line ends can be made visible with control "X SHIFT". If necessary, select a different value for R713.
- Set "TIME/div." to "1 µsec/div." and connect a 1-MHz signal to socket "YA".
- Set "X MAGN." to "CAL" and check the linearity of the trace, i.e. the maximum period-width deviation should not exceed 0.1 division.

Beam deflection
- Set "LEVEL" to "AUT.".

– In positions "0.5", "1" and "2 μsec/div." of "TIME/div." check that the flyback of the sawtooth voltage is suppressed and that the brilliance of the time-base line is nearly constant over the entire length. With the fastest sweep speeds, 1 division of the flyback may be visible.

Brightness modulation

– Apply a negative pulse voltage of 15 V_{p-p}, 2 kHz to sockets BU9 and BU10 respectively.
– Check that at normal brightness the trace appears dotted.
(Trigger the time-base with brightness control voltage).

Output socket "TIME-BASE" (BU7)

– Check that the amplitude of the sawtooth voltage on BU7 is $\geqslant 4.5\ V_{p-p}$.

XI *Replacing parts*

A. GENERAL INFORMATION

All valves and other component parts have been taken from normal production stock. After replacing components it may be necessary to re-adjust the relevant circuit. For this, see Chapter "Checking and Adjusting" and the footnotes at the end of the List of Electrical Parts. When replacing components, the instrument must be switched off.

B. REPLACING THE CATHODE-RAY TUBE

1. Loosen the acceleration voltage connector.
2. Remove the protective cap, measuring lattice and contrast material.
3. Remove the valve-holder and all connections from the tube.
4. Push the tube out of the oscilloscope through the front opening.
5. When a new tube has been fitted, make sure that the time-base line runs horizontally. If not, adjust with lever "A" (Fig. 6).
6. Re-adjust the instrument according to chapter "Checking and adjusting".

XII *Information for assistance in fault finding*

A. MAINS TRANSFORMER VOLTAGES

The available unloaded voltage tappings are listed in the mains circuit diagram in the form of a table.

B. VOLTAGES AND WAVEFORMS IN THE INSTRUMENT

The d.c. voltage levels at the electrodes of the valves and transistors and the voltage waveforms in the time-base generator are shown at the relevant points on the diagrams and the printed circuit drawings. (Figs. 28—34).
The waveforms are measured under the following conditions:
– A 1-kc/s sine-wave signal on input socket "YA"
– Switch SK4 to position "2 msec/div.".
The d.c. voltage values which are indicated in the diagram and on the printed wiring plates have been measured with voltmeter PM2401. These values may slightly differ per instrument.

C. REMARK

Whenever it is desired to send the instrument to a PHILIPS workshop the following points should be observed:
– carefully pack the instrument in the original packing or, if not available, a wooden box,
– indicate as completely as possible the symptom(s) of the fault(s),
– tie on a label bearing name and address of sender,
– send the instrument direct to the appropriate PHILIPS address provided by the local organization.

XIII *Information concerning accessories*

A. ADAPTOR PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm plugs.

Fig. 15. Adaptor PM 9051

B. ATTENUATOR PROBE SETS PM 9326 AND PM 9327

These passive probe sets for the PM 3230 are equal but for the length of the probe cable, which is 1.15 m (3.8 ft) for the PM 9326 and 2 m (6.5 ft) for the PM 9327.

The sets consist of:

1 probe cable	Fig. 17a
1 earthing flex 15 cm (6″)	Fig. 17b
1 earthing flex 30 cm (1′)	Fig. 17c
1 measuring probe 1 : 1 (black)	Fig. 17d
1 measuring pin	Fig. 17e
1 measuring hook	Fig. 17f
1 attenuator probe 1 : 10 (grey)	Fig. 17g
1 measuring clip	Fig. 17h
1 box	Fig. 17i

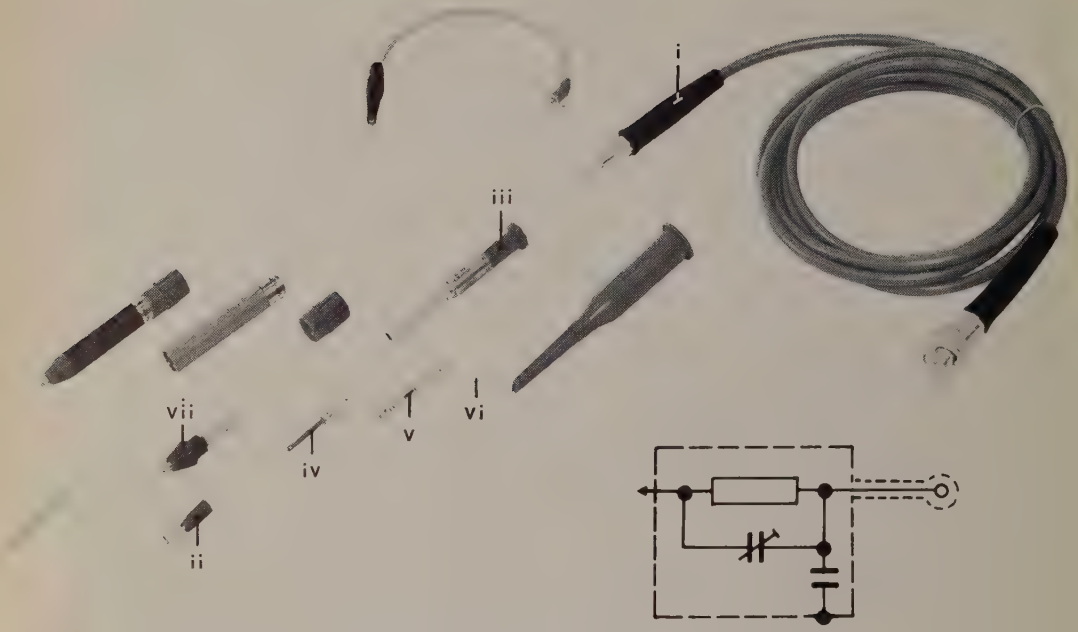


Fig. 16. Dismantling the probe

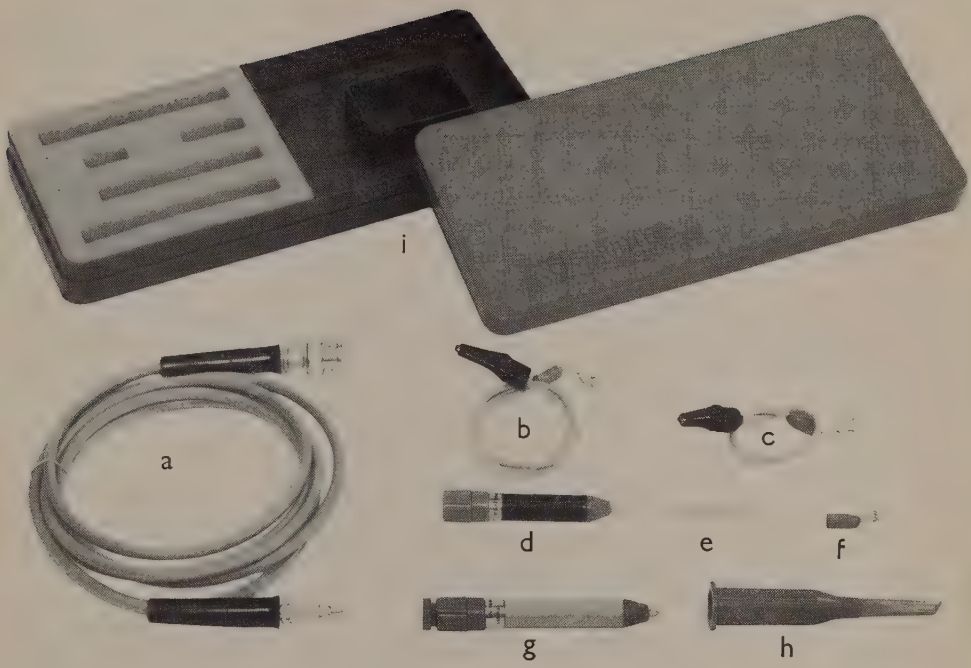


Fig. 17. Probe set

The attenuator probe may cause distortion if it is not correctly adjusted (see "Checking and adjusting" chapter XD).

1. Technical data

1. Technical data

Attenuation	: 1 : 10 ± 3 %
Input impedance	: 10 MΩ//8pF
Max. permissible input voltage	: 1,000 V_{p-p}.

Maximum d.c. component 500V with the blocking capacitor included into the circuit.

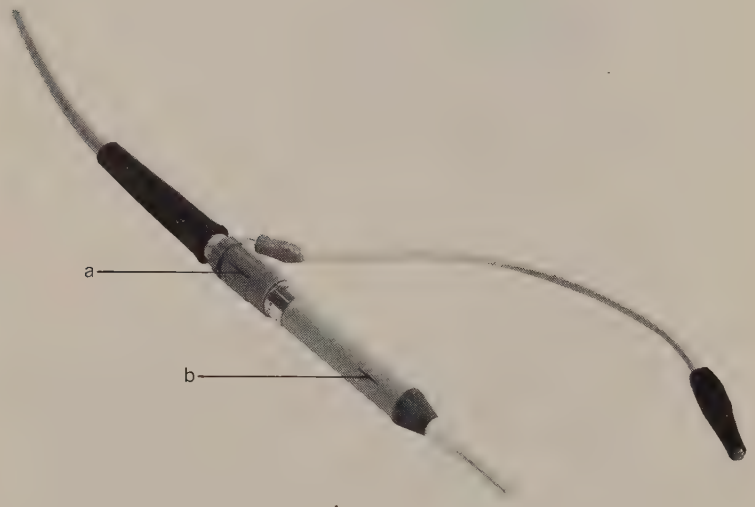


Fig. 18. Adjusting the probe

2. Adjustment (see Fig. 18)

- Unscrew the probe locking screw "a" by turning it anti-clockwise.
- Rotate the probe body "b" to change capacitance while watching display for desired wave form, as shown in Fig. 19.
- When compensation is completed, carefully turn the locking screw clockwise, to lock it without disturbing the adjustment.

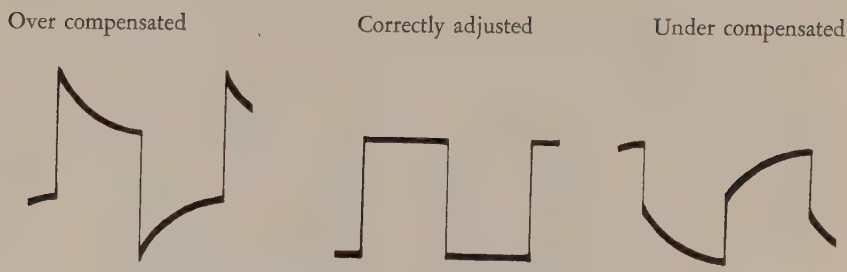


Fig. 19. Wave forms showing probe adjustment

3. **Dismantling the attenuator probe (see Fig. 16)**

- Pull the cable i from the probe.
- Screw the measuring hook ii from the probe.
- Unscrew rotor iii from the tube.
- The resistor with bushing iv, pressure spring v and contact vi can then be removed.
- Unscrew stator vii from the tube.

C. VIEWING HOOD PM 9370 (Fig. 20)

This is a rubber viewing hood for shielding the tube face from external light when the intensity of the light produced by the oscilloscope screen is low e.g. when observing phenomena with a low repetition frequency and a fast rise-time.

D. CARRYING CASE PM 9303 (Fig. 21)

This is a leather carrying case in which is room for a PM3230 and accessories such as two sets of measuring probes and measuring cables.

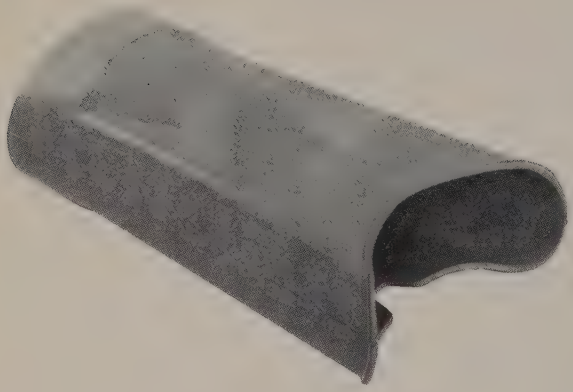


Fig. 20. Viewing hood

Fig. 21. Carrying case

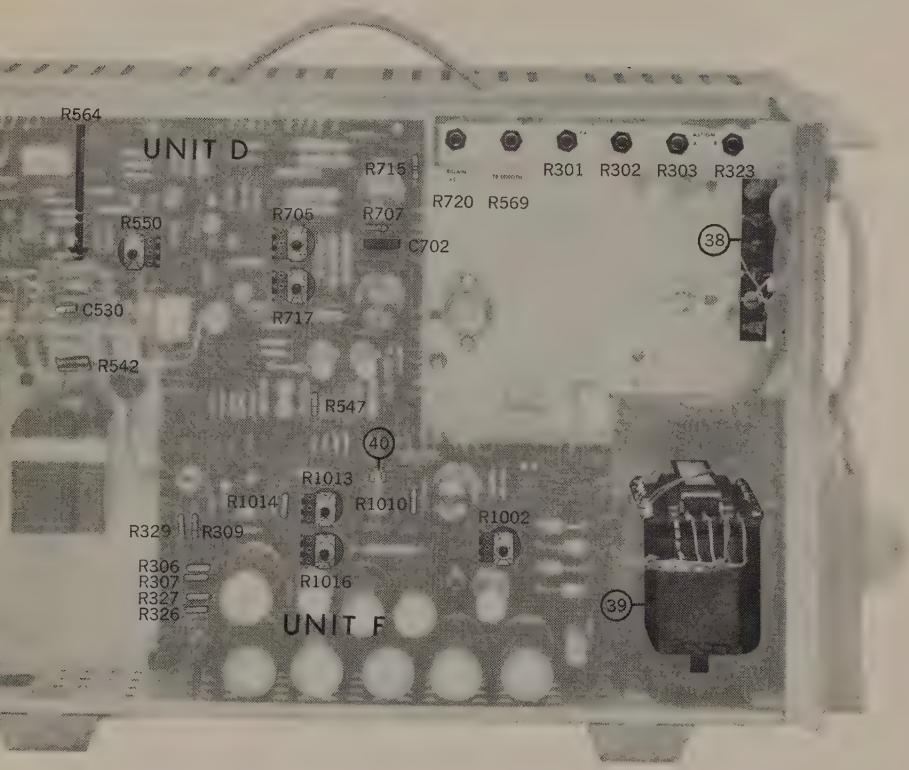


Fig. 22. Side view (right)
R329 should read R309
R309 should read R329

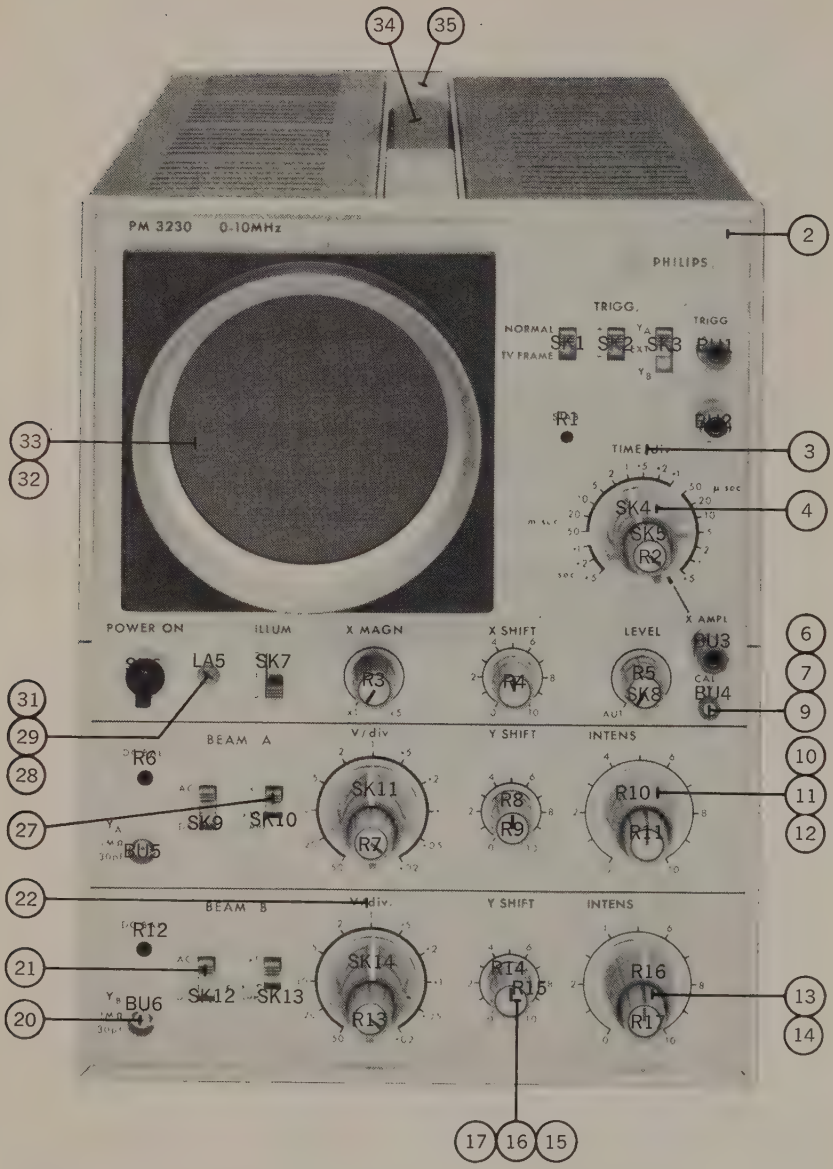


Fig. 23. Front view

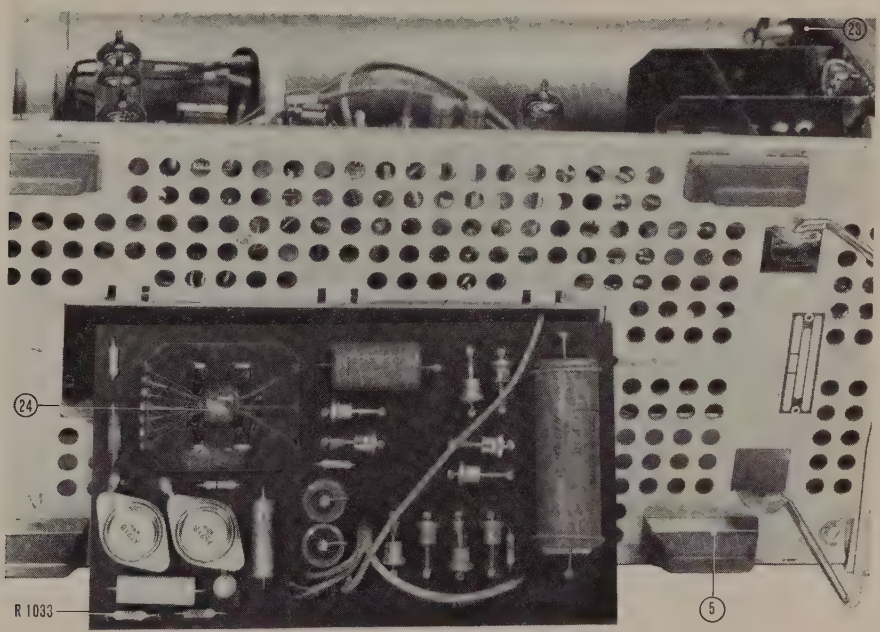


Fig. 24. Side view (left) and bottom

XIV *List of parts*

A. MECHANICAL

Item	*Fig.*	*Number*	*Ordering number*	*Description*
1	25	1	4822 256 40012	Fuse holder
2	23	1	4822 455 80011	Text plate
3	23	1	4822 273 80016	Time base switch without electr. parts
4	23	3	4822 413 40012	Knob, 23 mm dia.
5	24	4	4822 462 70221	Foot
		4	4822 492 60415.	Foot fixing spring
6	23	1	4822 325 80058	Insulation cal. outlet
7	23	1	4822 492 60416	Fixing spring cal. outlet
8	23	1	4822 693 80003	Mains cable container
9	23	1	4822 268 10031	Calibration contact
10	23	2	4822 532 50035	Plastic potentiometer spacer
11	23	2	4822 506 40009	Plastic fixing nut for potentiometer
12	23	2	4822 413 40211	Knob, 23 mm dia
13	23	5	4822 413 30085	Knob, 14.5 mm dia, shaft 4 mm dia
14	23	5	4822 413 70039	Cover, red arrow
15	23	5	4822 413 30082	Knob, 14.5 mm dia, shaft 6 mm dia
16	23	5	4822 413 70038	Cover, black arrow
17	23	5	4822 506 40007	Metal fixing nut for potentiometer
18	25	2	4822 290 40012	Earthing terminal
19	6	1	4822 290 30044	Anode cap.
20	23	1	4822 267 10004	BNC
21	23	4	4822 277 20009	Sliding switch, 3 positions
22	23	2	4822 273 60023	Attenuator switch without electr. parts
23	24	1	4822 277 10042	Mains switch
24	24	1	4822 150 60001	High voltage transformer
25	25	1	4822 253 30021	Fuse (VL1)
26	25	1	4822 321 10077	Mains cable
27	23	4	4822 277 20014	Sliding switch
28	23	1	4822 492 60414	Fixing spring pilot lamp
29	23	1	4822 381 10116	Lens
30	25	5	4822 290 40011	Terminal
31	23	1	4822 255 10007	Lampholder
32	23	1	4822 480 30036	Contrast filter
33	23	1	4822 450 10012	Graticule
34	23	1	4822 498 40068	Handle
35	23	2	4822 460 60011	Ornamental strip

Item	*Fig.*	*Number*	*Ordering number*	*Description*
36	6	4	4822 255 20022	Lampholder
37	6	22	4822 693 40002	Wiring-board clamp
38	22	1	4822 290 60058	Terminal strip (standard replacement)
39	22	1	4822 146 80045	Mains transformer
40	22	2	4822 492 60063	Fuse support (VL3)
		1	4822 252 20001	Thermal fuse (VL2)
		1	4822 253 30021	Fuse (VL3)
		1	4822 216 50127	Printed wiring board with parts, unit A
		1	4822 216 50118	Printed wiring board with parts, unit D
		1	4822 216 50026	Printed wiring board with parts, unit E
		1	4822 216 50119	Printed wiring board with parts, unit F

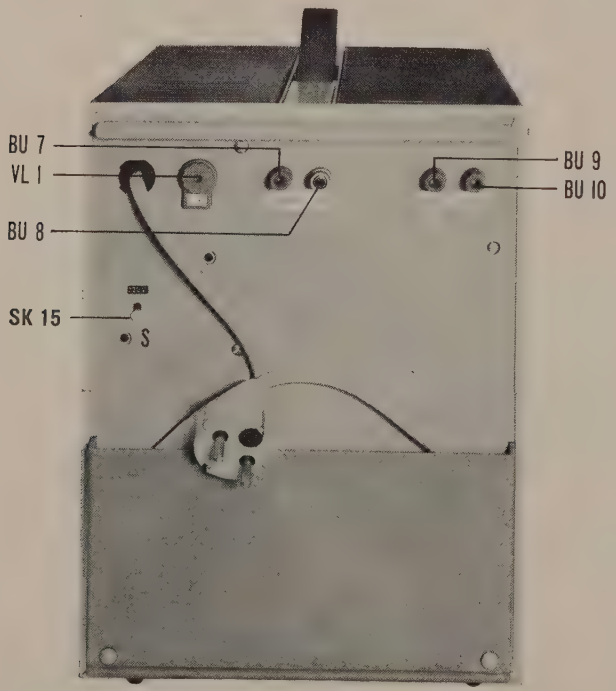


Fig. 25. Rear view

B. ELECTRICAL — ELEKTRISCH — ELEKTRISCH — ELECTRIQUE — ELECTRICOS

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,125 W 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
1 W ≦ 2,2 MΩ, 5%
> 2,2 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,25 W ≦ 1 MΩ, 5%
> 1 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
2 W 5%

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,5 W ≦ 5 MΩ, 1%
> 5 MΩ, 2%
> 10 MΩ, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
0,4 – 1,8 W 0,5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,5 W ≦ 1,5MΩ, 5%
> 1,5MΩ, 10%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
5,5 W ≦ 200 Ω, 10%
> 200 Ω, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
10 W 5%

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
500 V

Polyester capacitor
Polyesterkondensator
Polyesterkondensator
Condensateur au polyester
Condensador polyester
400 V

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
700 V

Flat-foil polyester capacitor
Miniatur-Polyesterkondensator (flach)
Platte miniatuur polyesterkondensator
Condensateur au polyester, type plat
Condensador polyester, tipo de placas planas
250 V

Ceramic capacitor, "pin-up"
Keramikkondensator "Pin-up" (Perltyp)
Keramische kondensator "Pin-up" type
Condensateur céramique, type perle
Condensador cerámico, versión "colgable"
500 V

Paper capacitor
Papierkondensator
Papierkondensator
Condensateur au papier
Condensador de papel
1000 V

"Microplate" ceramic capacitor
Miniatur-Scheibenkondensator
"Microplate" keramische kondensator
Condensateur céramique "microplate"
Condensador cerámico "microplaca"
30 V

Wire-wound trimmer
Drahttrimmer
Draadgewonden trimmer
Trimmer à fil
Trimmer bobinado

Mica capacitor
Glimmerkondensator
Micakondensator
Condensateur au mica
Condensador de mica
500 V

Tubular ceramic trimmer
Rohrtrimmer
Buisvormige keramische trimmer
Trimmer céramique tubulaire
Trimmer cerámico tubular

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.
Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.
Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.
Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.
Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

RESISTORS

Item	*Ordering number*	*Value*	*%*	*W*	*Description*
R1	4822 101 20074	2.2 kΩ	20	0.1	linear potentiometer
R2	4822 101 40043	22 kΩ	20	0.25	linear potentiometer
R3	4822 103 20084	1 kΩ	5	3	linear potentiometer
R4*	4822 101 20109	10 kΩ	20	0.25	linear potentiometer
R5*	4822 101 40011	4.7 kΩ	20	0.25	linear potentiometer
R6	4822 101 20074	2.2 kΩ	20	0.1	linear potentiometer
R7	4822 101 20146	500 Ω	20		linear potentiometer
R8)* R9)	4822 102 30027	100 kΩ	20	0.25	linear tandem potentiometer
R10)* R11)	4822 102 10102	2.2 MΩ	20	0.25	linear twin potentiometer
R12	4822 101 20074	2.2 kΩ	20	0.1	linear potentiometer
R13	4822 101 20146	500 Ω	20		linear potentiometer
R14)* R15)	4822 102 30027	100 kΩ	20	0.25	linear tandem potentiometer
R16)* R17)	4822 102 10102	2.2 MΩ	20	0.25	linear tandem potentiometer
R27, R127	4822 116 50197	900 kΩ	1	0.125	carbon
R28, R128	4822 116 50046	990 kΩ	1	0.125	carbon
R31, R131	4822 116 50009	111 kΩ	1	0.125	carbon
R32, R132	4822 116 50284	10.1 kΩ	1	0.125	carbon
R36, R136	4822 111 20144	600 kΩ	1	0.125	carbon
R37, R137	4822 111 20147	800 kΩ	1	0.125	carbon
R38, R138	4822 116 50021	666 kΩ	1	0.125	carbon
R39, R139	4822 116 50193	250 kΩ	1	0.125	carbon
R48, R148	4822 101 20074	2.2 kΩ	20	0.1	potentiometer
R91, R191	4822 101 20154	220 Ω	20	0.1	potentiometer
R111, R211	4822 101 20241	1 kΩ	20	0.1	potentiometer
R301	4822 101 20081	470 kΩ	20	0,1	potentiometer
R302	4822 101 20081	470 kΩ	20	0,1	potentiometer
R303	4822 101 20081	470 kΩ	20	0,1	potentiometer

*) Potentiometer bushings 4822 532 20158 for adapting 5 mm to 6 mm shafts hould be ordered with these items.

Item	*Description*	*Value*	*%*	*W*	*Ordering number*
R323	4822 101 20081	470 kΩ	20	0.1	potentiometer
R550	4822 100 20076	4.1 kΩ	20	0.1	potentiometer
R552 5)	4822 110 30181	280 kΩ	1	0.25	carbon (2 in par.)
R553 5)	4822 116 50161	140 kΩ	1	0.25	carbon
R554 5)	4822 111 20093	70 kΩ	1	0.25	carbon
R556	4822 111 20097	700 kΩ	1	0.25	carbon
R569	4822 101 20074	2.2 kΩ	20	0.1	potentiometer
R705	4822 101 20076	4.7 kΩ	20	0.1	potentiometer
R717	4822 101 20076	4.7 kΩ	20	0.1	potentiometer
R720	4822 101 20074	2.2 kΩ	20	0.1	potentiometer
R1002	4822 101 20154	220 Ω	20	0.1	potentiometer
R1013	4822 101 20241	1 kΩ	20	0.1	potentiometer
R1016	4822 101 20241	1 kΩ	20	0.1	potentiometer

COILS

Item	*Ordering number*	*Description*
L1001	4822 157 50223	suppressor coil

Limit values of choice elements.

When the instrument is adjusted the values of choice resistors and capacitors should be selected within the following limits.

The choice elements can be recognised in the circuit diagrams by the hatching over the elements and the lacking of a value indication.

Capacitors

C66(166)	82 ... 220 pF				
C69(169)	82 ... 220 pF				
C71(171)	82 ... 150 pF				
C530	1.5 ... 5.6 pF				
C702	ca. 680 pF				

Resistors

R49(149)	4.7 ... 15 kΩ	R329	1 ... 3.3 MΩ		
R62(162)	4.7 ... 15 kΩ	R542	1 ... 3 MΩ		
R71(171)	0 ... 560 kΩ	R547	1 ... 1.5 kΩ		
R74(174)	0 ... 560 kΩ	R564	4.7 ... 8.2 kΩ		
R79(179)	3.3 ... 10 kΩ	R707	1.5 ... 3.3 kΩ		
R92(192)	1 ... 6.8 kΩ	R713	12 ... 33 kΩ		
R306	1.2 ... 3.3 MΩ	R715	0 ... 47 Ω		
R307	270 ... 820 kΩ	R1010	130 kΩ ... 1 MΩ		
R309	1 ... 3.3 MΩ	R1014	1 ... 6.8 kΩ		
R326	1.2 ... 3.3 MΩ	R1034	33 ... 100 kΩ		
R327	270 ... 820 kΩ				

CAPACITORS

Item	*Ordering number*	*Value*	*%*	*V*	*Description*
C26, C126	4822 121 40145	100 nF	10	630	plate capacitor
C35, C135	4822 124 20078	125 µF		16	electrolytic
C52, C152	4822 124 20059	2.5 µF		64	electrolytic
C57, C157	4822 124 20079	2.5 µF		16	electrolytic
C62, C162	4822 125 50026	8.5 µF		50	trimmer
C72, C172	4822 125 50017	60 µF		50	trimmer
C502	4822 124 20079	2.5 µF		16	electrolytic
C503	4822 125 20054	25 µF		25	electrolytic
C512	4822 124 20097	32 µF		64	electrolytic
C514	4822 124 20053	160 µF		25	electrolytic
C520	4822 124 20093	10 µF		64	electrolytic
C521	4822 121 10105	10 µF	0.5	200	box capacitor
C522		1 µF	0.5	200	
C523	4822 111 30192	100 nF	0.5	200	box capacitor
C524		10 nF	0.5	200	
C526	4822 123 10204	975 pF	1	500	mica
C527	4822 120 60093 4822 120 60077	375 pF	1	500	mica (in par.)
C528	4822 120 60085 4822 120 60062	170 pF	1	500	
C529	4822 120 60076	68 pF	1	500	mica (in par.)
C532	4822 124 20053	160 µF		25	electrolytic
C1001	4822 124 40059	100 µF		300	electrolytic
C1003	4822 124 20247	160 µF		64	electrolytic
C1004	4822 124 40059	100 µF		300	electrolytic
C1006	4822 124 40045	100 µF		150	electrolytic
C1007	4822 124 40045	100 µF		150	electrolytic
C1008	4822 124 40011	800 µF		40	electrolytic (3 in par.)
C1009	4822 124 20182	250 µF		40	electrolytic
C1022	4822 124 20053	160 µF		25	electrolytic
C1024	4822 121 30062	10 nF		3000	HT capacitor
C1026	4822 121 30063	10 nF		5000	HT capacitor
C1027	4822 121 40123	15 nF		1600	HT capacitor
C1028	4822 121 40123	15 nF		1600	HT capacitor

VALVES, SEMI-CONDUCTORS ETC.

Item	*Type*	*Ordering code*	*Description*
B27	ECC88		double triode
B28	ECC88		double triode
B127	ECC88		double triode
B128	ECC88		double triode
B301	E10-12GP		c. r. t.
B305	ZZ1000		neon stabilizer
B701	E810F		pentode
B702	E810F		pentode
B1001	ECC88		double triode
B1002	ZZ1000		neon stabilizer
[1]) TS26′	AF118	4822 130 40251	germanium transistor
[1]) TS26″	AF118	4822 130 40251	germanium transistor
[1]) TS28′	AF118	4822 130 40251	germanium transistor
[1]) TS28″	AF118	4822 130 40251	germanium transistor
TS30	AF118	4822 130 40251	germanium transistor
TS31	AF118	4822 130 40251	germanium transistor
[2]) TS32	BFW10	4822 130 40443	field effect transistor
[2]) TS33	BFW10	4822 130 40443	field effect transistor
TS34	BF115	4822 130 40308	silicon transistor
TS36	BF115	4822 130 40308	silicon transistor
[1]) TS126′	AF118	4822 130 40251	germanium transistor
[1]) TS126″	AF118	4822 130 40251	germanium transistor
[1]) TS128′	AF118	4822 130 40251	germanium transistor
[1]) TS128″	AF118	4822 130 40251	germanium transistor
TS130	AF118	4822 130 40251	germanium transistor
TS131	AF118	4822 130 40251	germanium transistor
[2]) TS132	BFW10	4822 130 40443	field effect transistor
[2]) TS133	BFW10	4822 130 40443	field effect transistor
TS134	BF115	4822 130 40308	silicon transistor
TS136	BF115	4822 130 40308	silicon transistor
TS501	FW5324	4822 130 40142	Fairchild silicon transistor
TS502	FW5324	4822 130 40142	Fairchild silicon transistor
TS503	BSY39	4822 130 40125	silicon transistor
TS504	BSY39	4822 130 40125	silicon transistor
TS505	FW5435	4822 130 40142	Fairchild silicon transistor
TS506	FW5435	4822 130 40142	Fairchild silicon transistor
TS507	AF118	4822 130 40251	germanium transistor
TS509	AF118	4822 130 40251	germanium transistor
TS510	BSY11	4822 130 40293	silicon transistor
TS511	BSY11	4822 130 40293	silicon transistor
TS512	2N930	4822 130 40051	silicon transistor
[3]) TS513	2N929	4822 130 40047	silicon transistor
TS514	FW5435	4822 130 40142	Fairchild silicon transistor

Item	*Type*	*Ordering code*	*Description*
TS515	AF118	4822 130 40251	germanium transistor
TS1001	ASZ16	4822 130 40279	germanium transistor
TS1002	AC128	4822 130 40095	germanium transistor
TS1003	AF124	4822 130 40255	germanium transistor
TS1004	AF124	4822 130 40255	germanium transistor
TS1006	ASZ18	4822 130 40282	germanium transistor
TS1007	ASZ18	4822 130 40282	germanium transistor
GR26	BZY63	4822 130 30245	zener diode
GR27	BAY38	4822 130 40256	silicon diode
GR28	BAX13	4822 130 40182	silicon diode
GR29	BA114	4822 130 30189	silicon diode
GR30	OA202	4822 130 30239	silicon diode
GR31	BA114	4822 130 30189	silicon diode
GR32	BZY63	4822 130 30245	zener diode
GR33	OA202	4822 130 30239	silicon diode
GR34	OA202	4822 130 30239	silicon diode
GR126	BZY63	4822 130 30245	zener diode
GR127	BAY38	4822 130 40256	silicon diode
GR128	BAX13	4822 130 40182	silicon diode
GR129	BA114	4822 130 30189	silicon diode
GR130	OA202	4822 130 30239	silicon diode
GR131	BA114	4822 130 30189	silicon diode
GR132	BZY63	4822 130 30245	silicon diode
GR133	OA202	4822 130 30239	silicon diode
GR134	OA202	4822 130 30239	silicon diode
GR501	AAZ15	4822 130 30229	germanium diode
GR502	BAY38	4822 130 40256	silicon diode
GR504	BZY62	4822 130 30133	zener diode
GR701	OA202	4822 130 30239	silicon diode
GR702	OA202	4822 130 30239	silicon diode
GR1001	BY123	4822 130 30279	rectifier
GR1003	BY127	4822 130 30259	silicon diode
GR1004	BY127	4822 130 30259	silicon diode
GR1005	BY127	4822 130 30259	silicon diode
GR1006	BY127	4822 130 30259	silicon diode
[4]) GR1007	OAZ212	4822 130 30251	zener diode
GR1008	OA202	4822 130 30239	silicon diode
GR1009	OA202	4822 130 30239	silicon diode
GR1011	OAZ203	4822 130 30143	zener diode
GR1012	BYX10	4822 130 30195	silicon diode
GR1013	BYX10	4822 130 30195	silicon diode
GR1014	BYX10	4822 130 30195	silicon diode
GR1015	BYX10	4822 130 30195	silicon diode
GR1016	BYX10	4822 130 30195	silicon diode
GR1017	BYX10	4822 130 30195	silicon diode

Item	*Type*	*Ordering code*	*Description*
GR1018	BYX10	4822 130 30195	silicon diode
GR1019	BYX10	4822 130 30195	silicon diode
GR1020	BYX10	4822 130 30195	silicon diode
GR1021	BYX10	4822 130 30195	silicon diode
GR1022	OA202	4822 130 30239	silicon diode
GR1023	OA202	4822 130 30239	silicon diode
GR1024	OA202	4822 130 30239	silicon diode
GR1025	OA202	4822 130 30239	silicon diode
LA1...4	6828	4822 134 40054	lamp
LA5	8034D	4822 134 40011	lamp

C. PARTS OF THE MEASURING PROBES (Fig. 17) PM 9326 AND PM 9327.

Item	*Qty*	*Ordering number*	*Description*
a	1	4822 320 10042	Probe cable 2 m (6.5') for PM 9327.
	1	4822 321 20087	Probe cable 1.15 m (3.8') for PM 9326.
b	1	4822 321 20096	Earthing flex 15 cm (6").
c	1	4822 321 20134	Earthing flex 30 cm (12").
d	1	4822 266 20015	Measuring probe 1 : 1 (black).
e	1	4822 268 10029	Measuring pin.
f	1	4822 268 10039	Measuring hook.
g	1	4822 210 70044	Attenuator probe 1 : 10 (grey).
h	1	4822 264 20009	Measuring clip.
	1	4822 111 20155	Resistor.

Attention !

1) Transistors TS26'-26" (TS126'-126") and TS28'-28" (TS128'-128") should be selected as a matched pair (tolerance 3.5 %) with respect to the hfe factor in the range 60 $\leqslant$ hfe $\leqslant$ 100.

   Note: If one of the abovestated transistors is replaced, carry out the following check:
   — Adjust the balance according to chapter VI B, section 1b.
   — Set switch "$\times$ 1 - $\times$ 10" from position "$\times$ 10" to position "$\times$ 1".
   — Check if the line does not jump more than 1.5 division. If desired, select a different value for R74 (R174) or R71 (R171), readjust the balance and repeat the check.
   — Next, set switch "AC-O-DC" to position "DC" and short-circuit socket "YA" against earth.
   When doing this, the trace may not jump more than ¼ of a division.

2) The F.E.T.s BFW10, TS32-33 (TS132-133) should be matched as pairs in the following way.
   Apply a voltage of + 9V to the drain via a resistor of 47 Ω. Apply a voltage of —15 V to the source via a resistor of 10 kΩ. Earth the gate via a resistor of 1 MΩ.
   Measure the gate-source voltage. For a pair this should not differ more than 100 mV.

3) Transistor TS513 (2N929) should be selected for an hfe $<$ 150 at a current of 5 mA.

4) When for diode GR1007 an OAZ213 is used in stead of an OAZ212, it should be selected for a Zener voltage of $\leqslant$ 12 V.

5) Resistors R552, 553, 554 should be selected within ½ % tolerance. All three resistors should have identical tolerances, i.e. all positive or all negative.

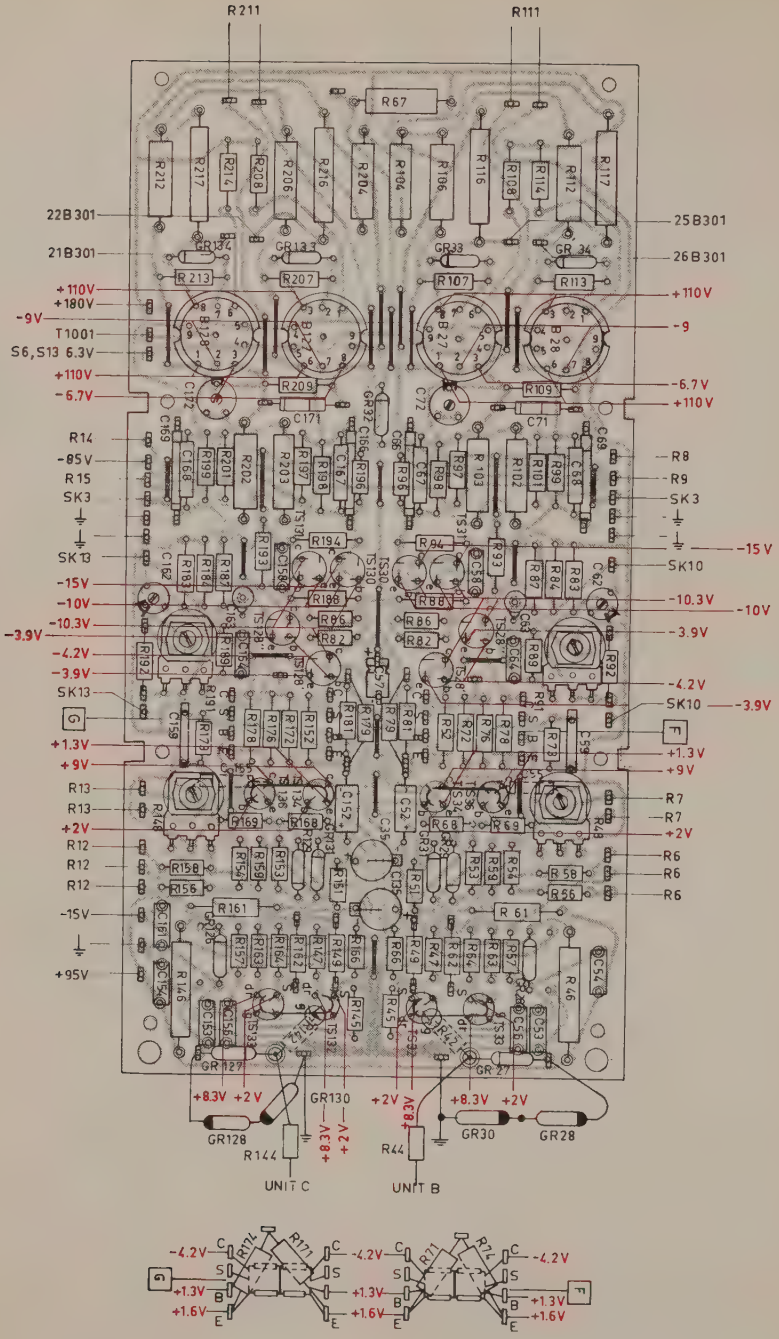


Fig. 26. Printed circuit unit A

PEM 4864

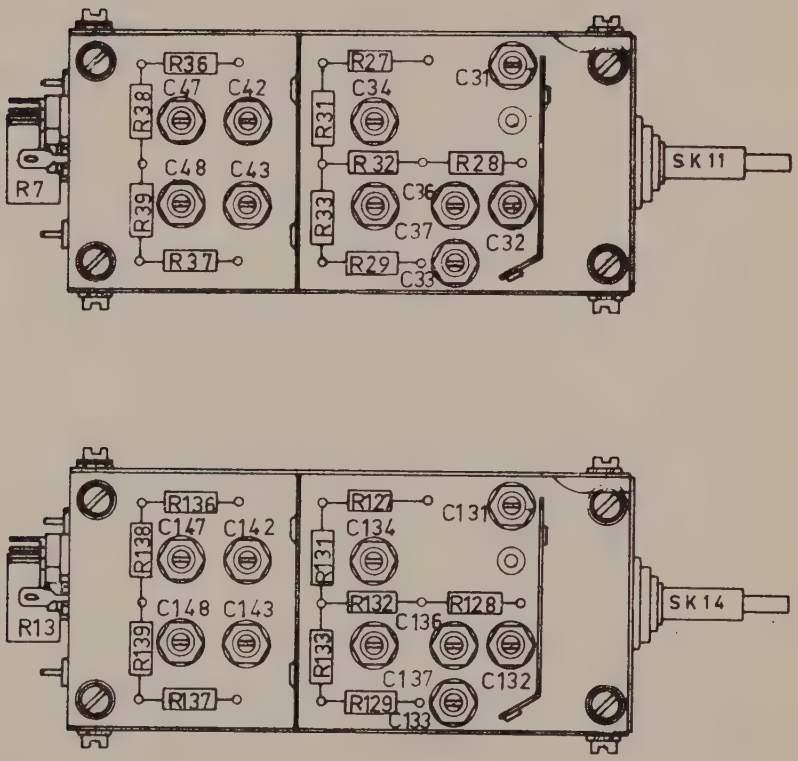
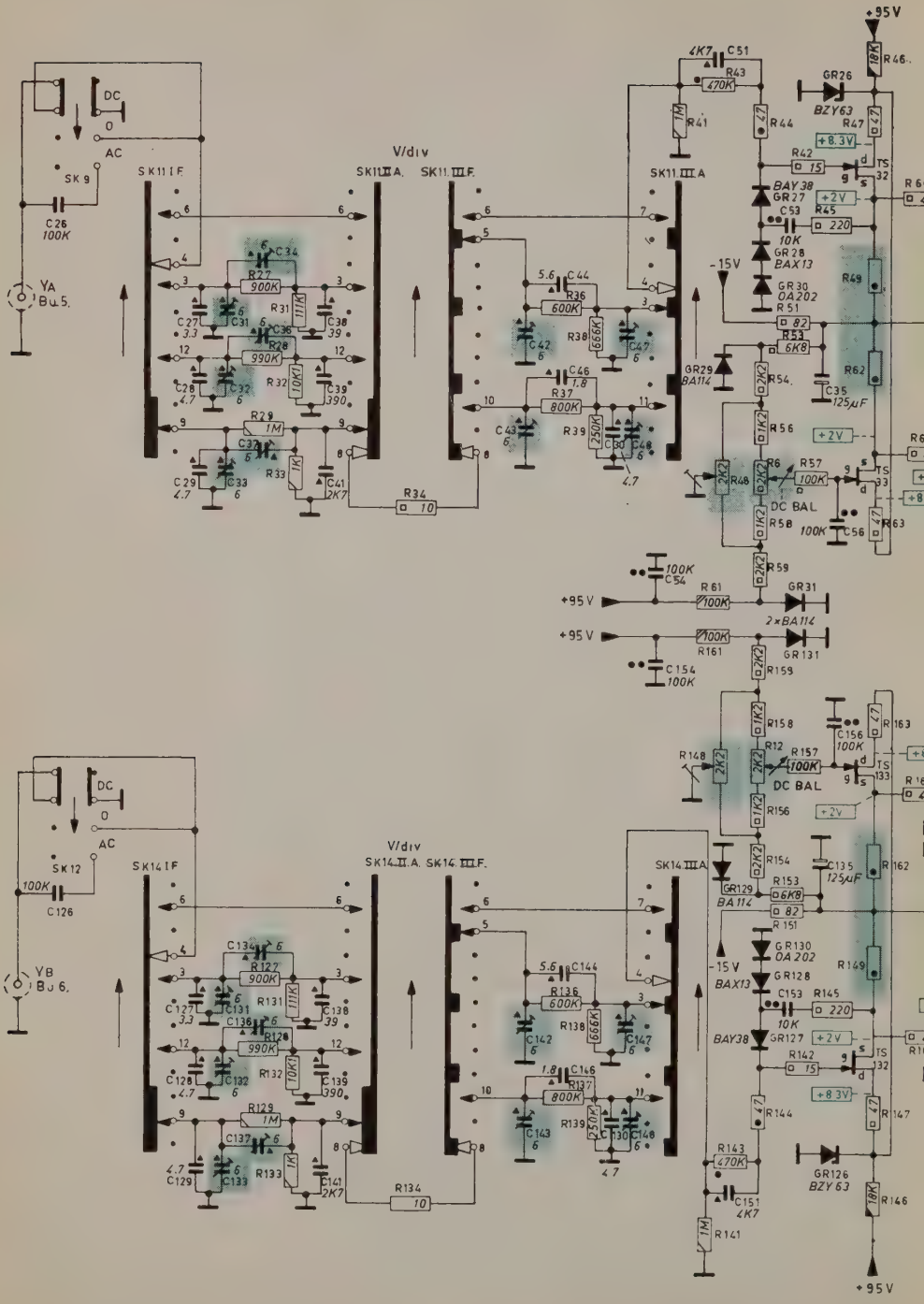


Fig. 27. Printed circuit, units B and C


DC
AC
SK 9
C26 100K
YA Bu 5.
SK11 I F
V/div
SK11 II A, SK11 III F
SK11 III A
+95V
4K7 C51
R43 470K
GR26 BZY63
R41 1M
R44 47
R47 47
+8.3V
R42 15
BAY 38 GR27
+2V
C53 10K
R45 220
GR28 BAX13
-15V
GR30 OA202
R51 82
R53 6K8
GR29 BA114
R54 2K2
C35 125µF
R56 1K2
R48 2K2
R57 100K
DC BAL
R58 1K2
C56 100K
R63 47
C54 100K
R61 100K
GR31 2xBA114
+95V
R161 100K
GR131
C154 100K
R159 2K2
R158 1K2
C156 100K
R163 47
R148 2K2
R12 2K2
R157 100K
DC BAL
R156 1K2
+2V
SK 12
100K C126
YB Bu 6.
SK14 I F
V/div
SK14 II A, SK14 III F
SK14 III A
R154 2K2
C135 125µF
R162 47
GR129 BA114
R153 6K8
R151 82
GR130 OA 202
GR128 BAX13
R149 47
C153 10K
R145 220
BAY38 GR127
+2V
R142 15
+8.3V
R144 47
R147 47
R143 470K
GR126 BZY 63
C151 4K7
R146 10K
R141 1M
+95V

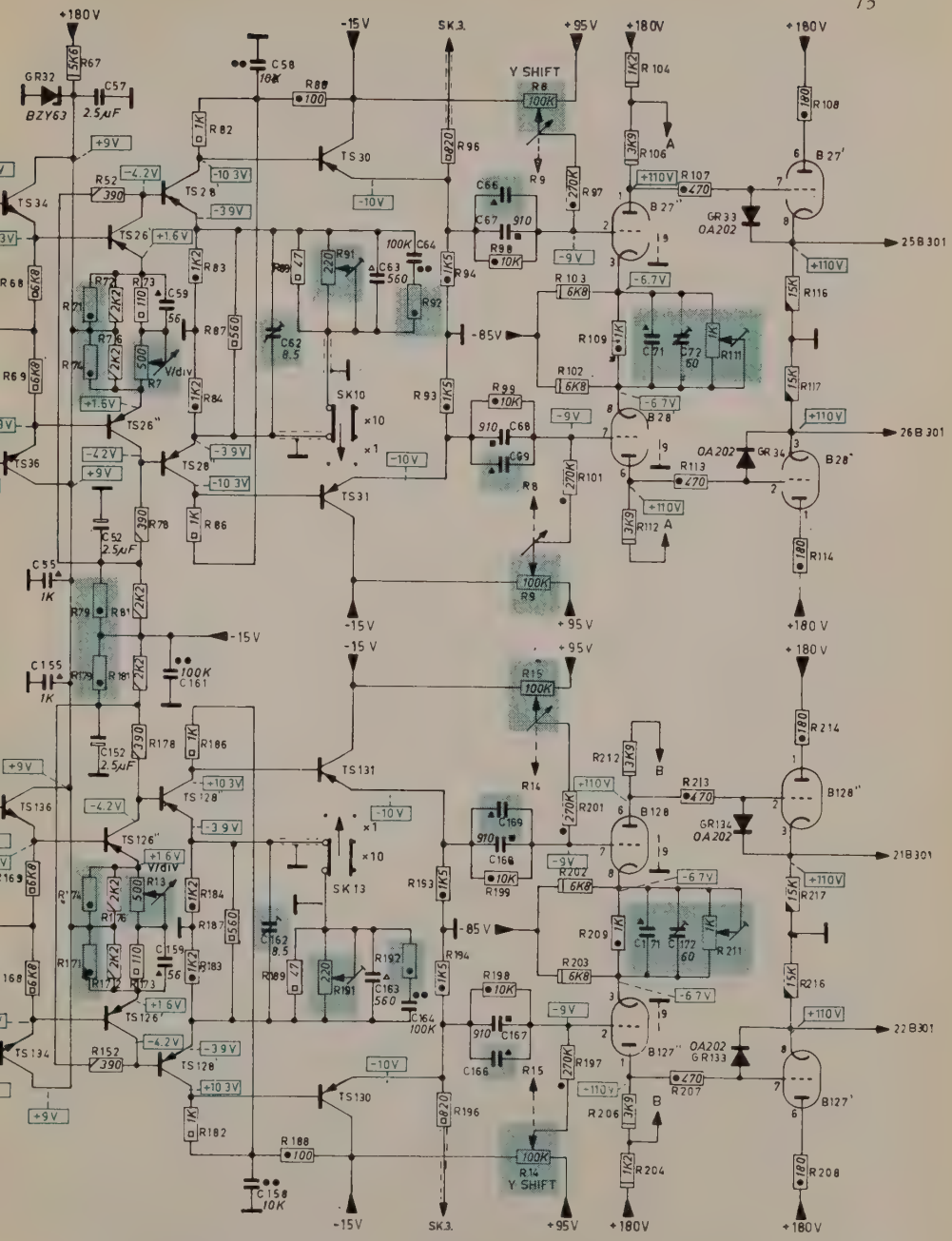


Fig. 28. Circuit diagram, Y-amplifier

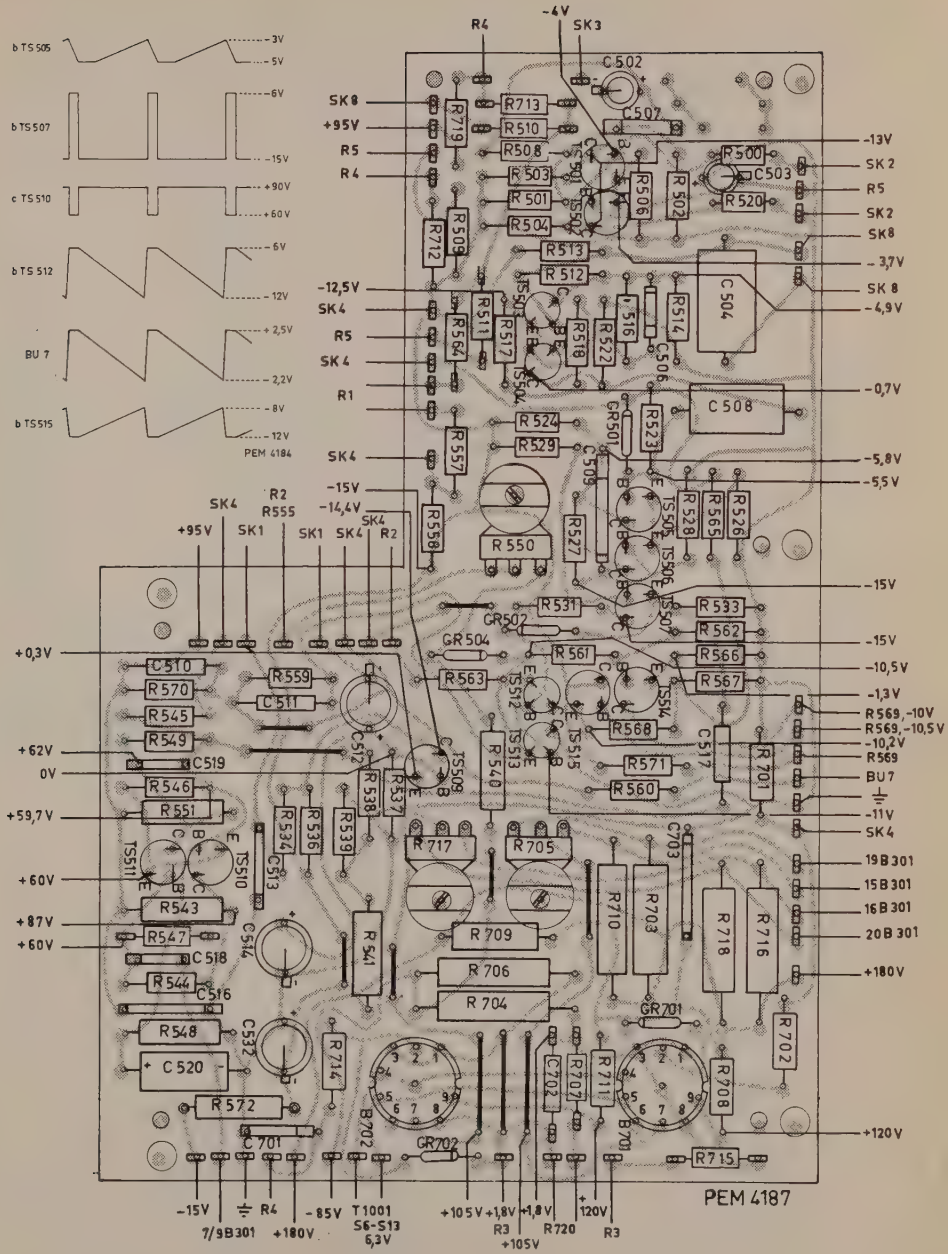
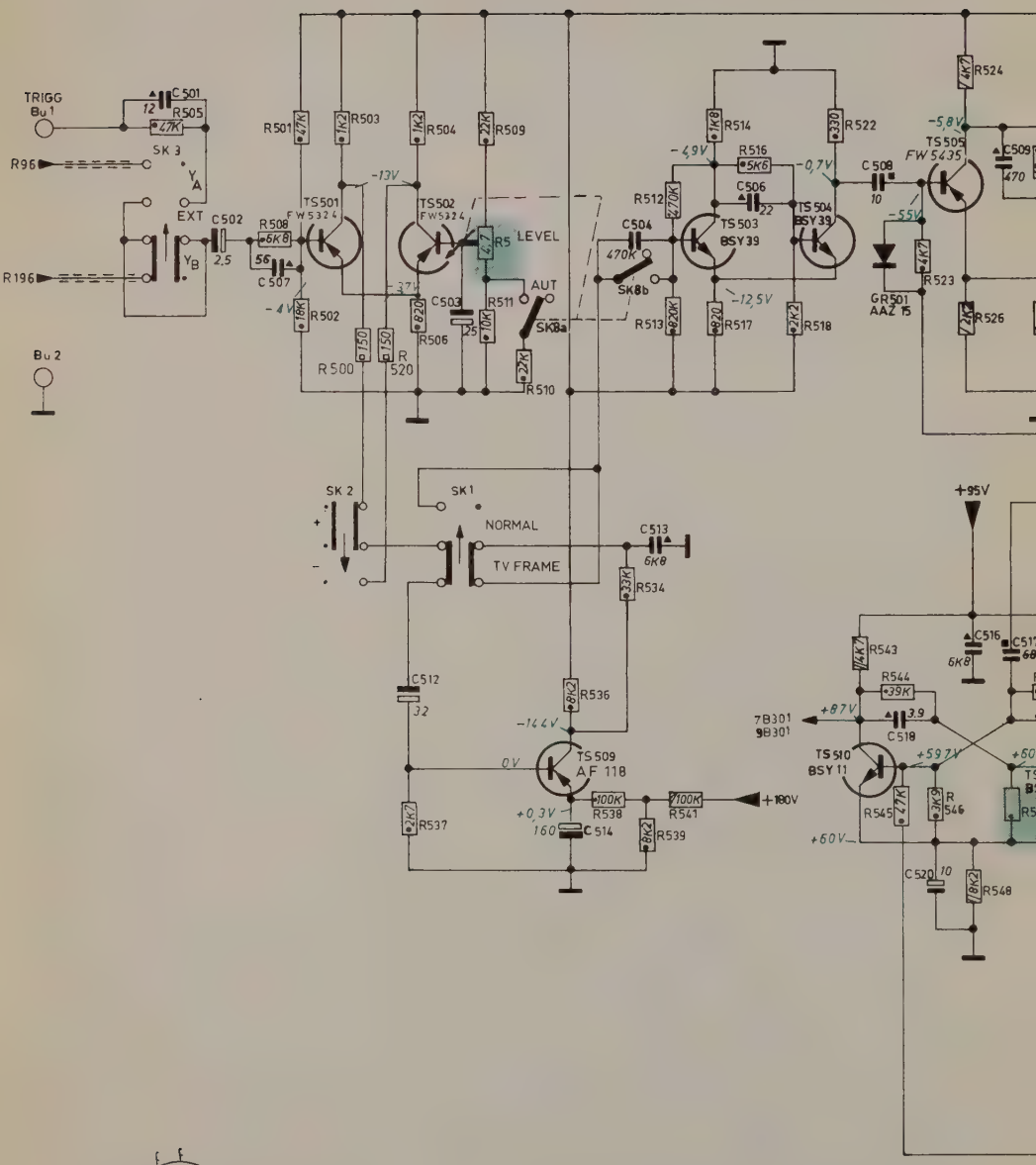


Fig. 29. Printed circuit unit D



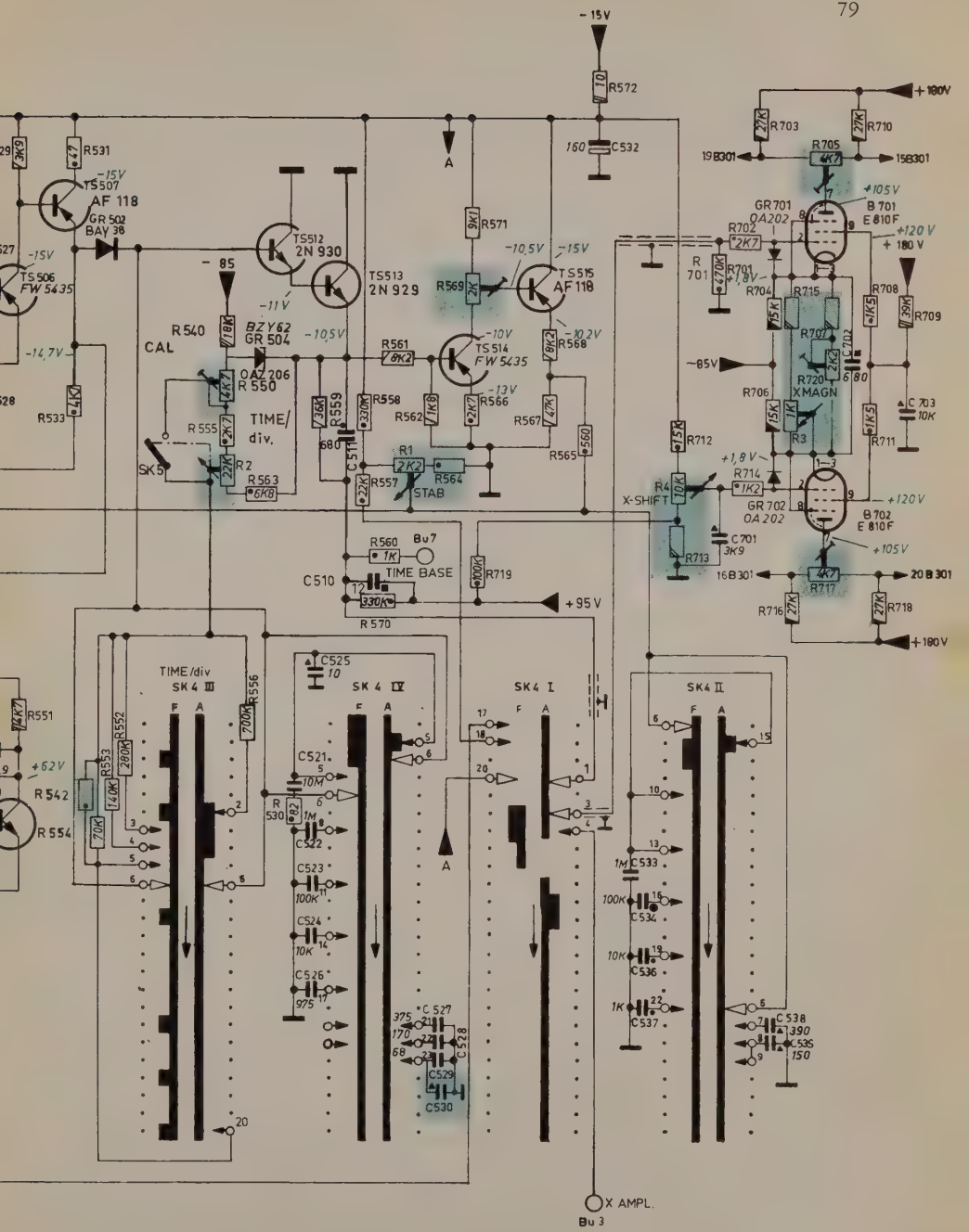
B701
B702

TS501, 502, 503, 504, 505, 506, 510, 511, 512, 513, 514

C S BE
TS507, 509

GR501, 502, 504, 701, 712

Erratum:
C525 should be connected
in stead of 5 SK4 IV.



6 SK4 IV

PEM 3706 B

Fig. 30. Circuit diagram - pulse-shaper, time-base generator, X-amplifier

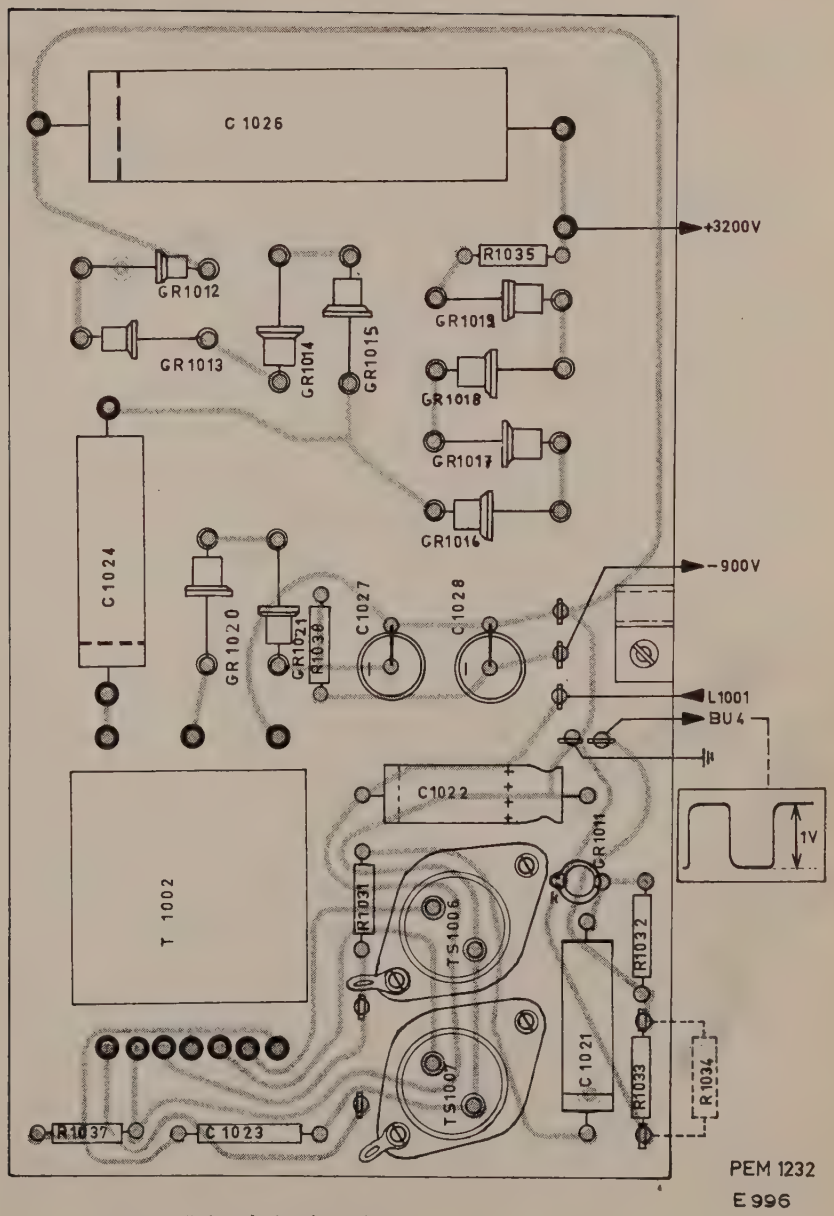
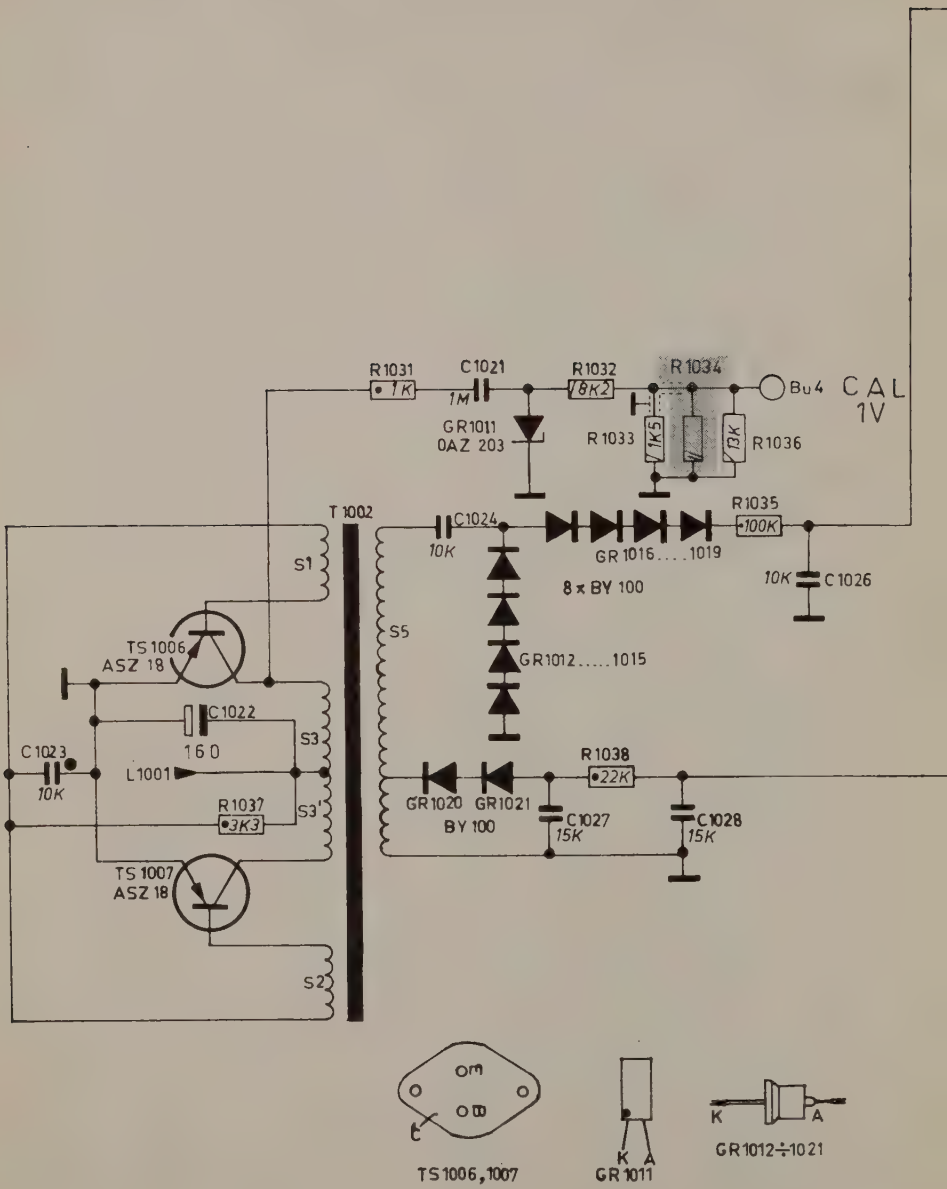


Fig. 31. Printed circuit, unit E


R1031
1K
C1021
1M
R1032
8K2
R1034
Bu4
CAL
1V
GR1011
0AZ 203
R1033
1K5
13K
R1036
T1002
C1024
10K
R1035
100K
GR1016....1019
8 x BY 100
10K
C1026
S1
S5
TS1006
ASZ 18
GR1012.....1015
C1022
160
S3
C1023
10K
L1001
R1038
22K
R1037
3K3
S3'
GR1020
GR1021
BY 100
C1027
15K
C1028
15K
TS1007
ASZ 18
S2
TS1006,1007
K A
GR1011
K A
GR1012÷1021

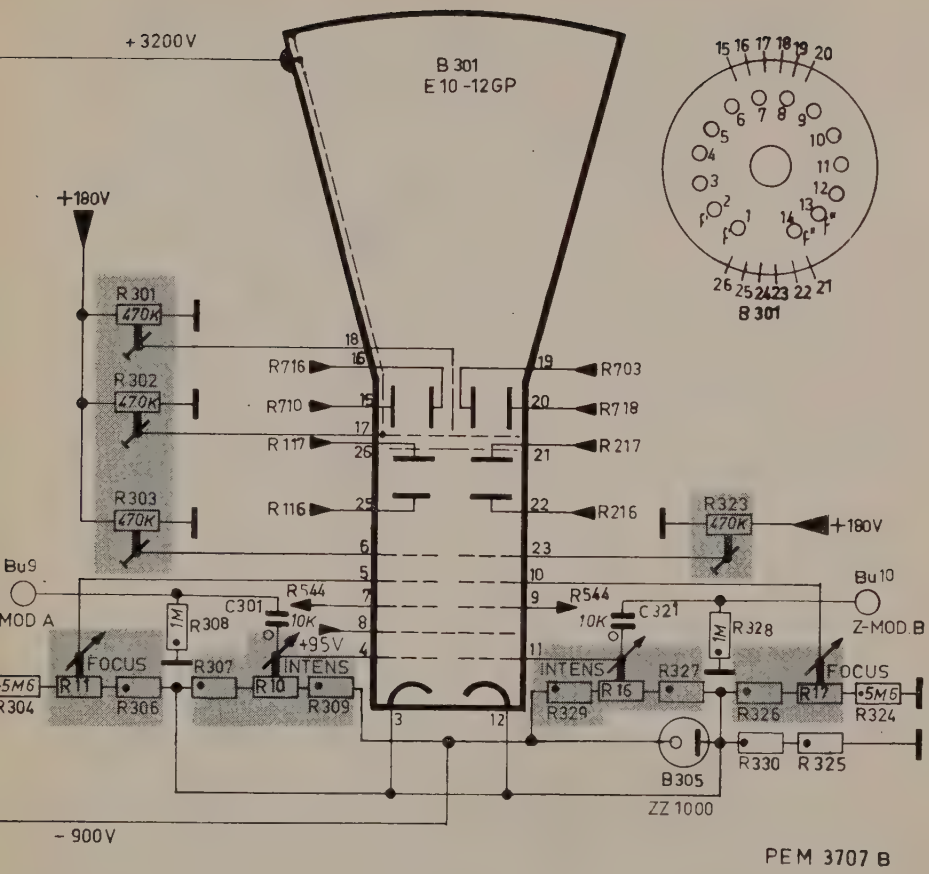


Fig. 32. Circuit diagram-high-voltage unit and cathode-ray tube

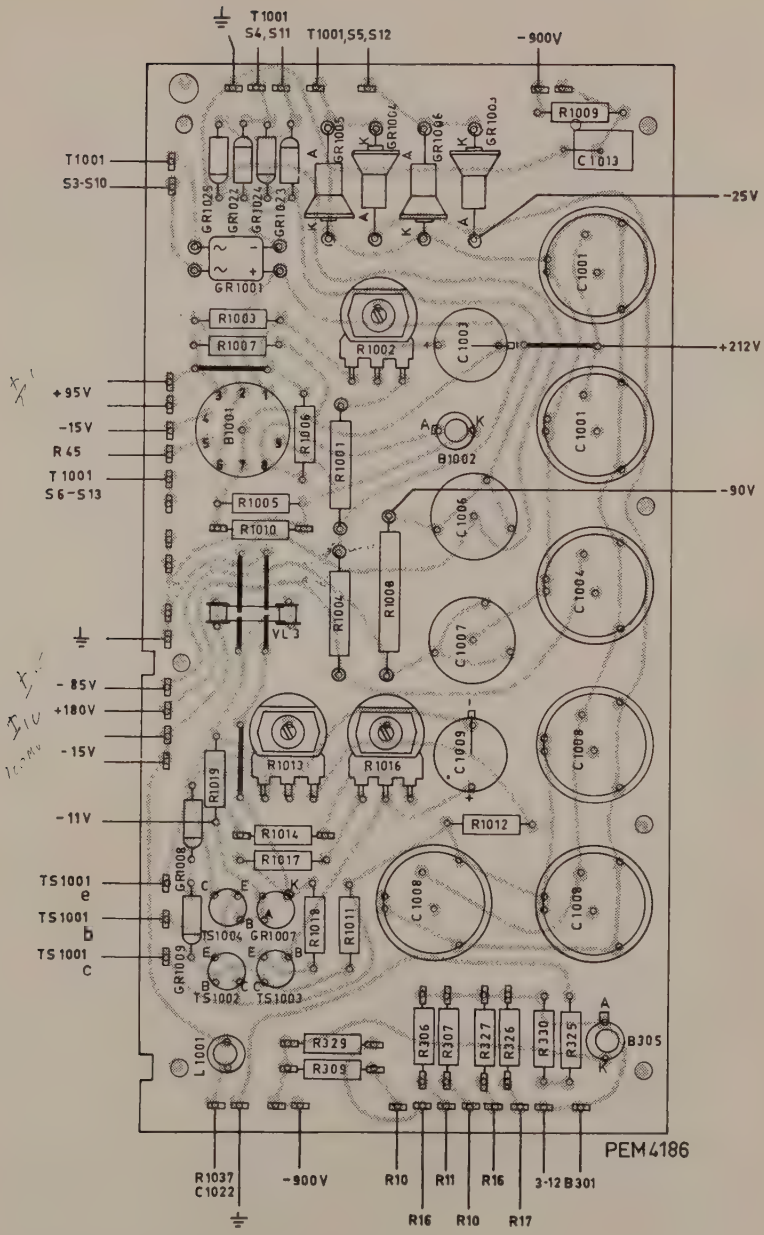
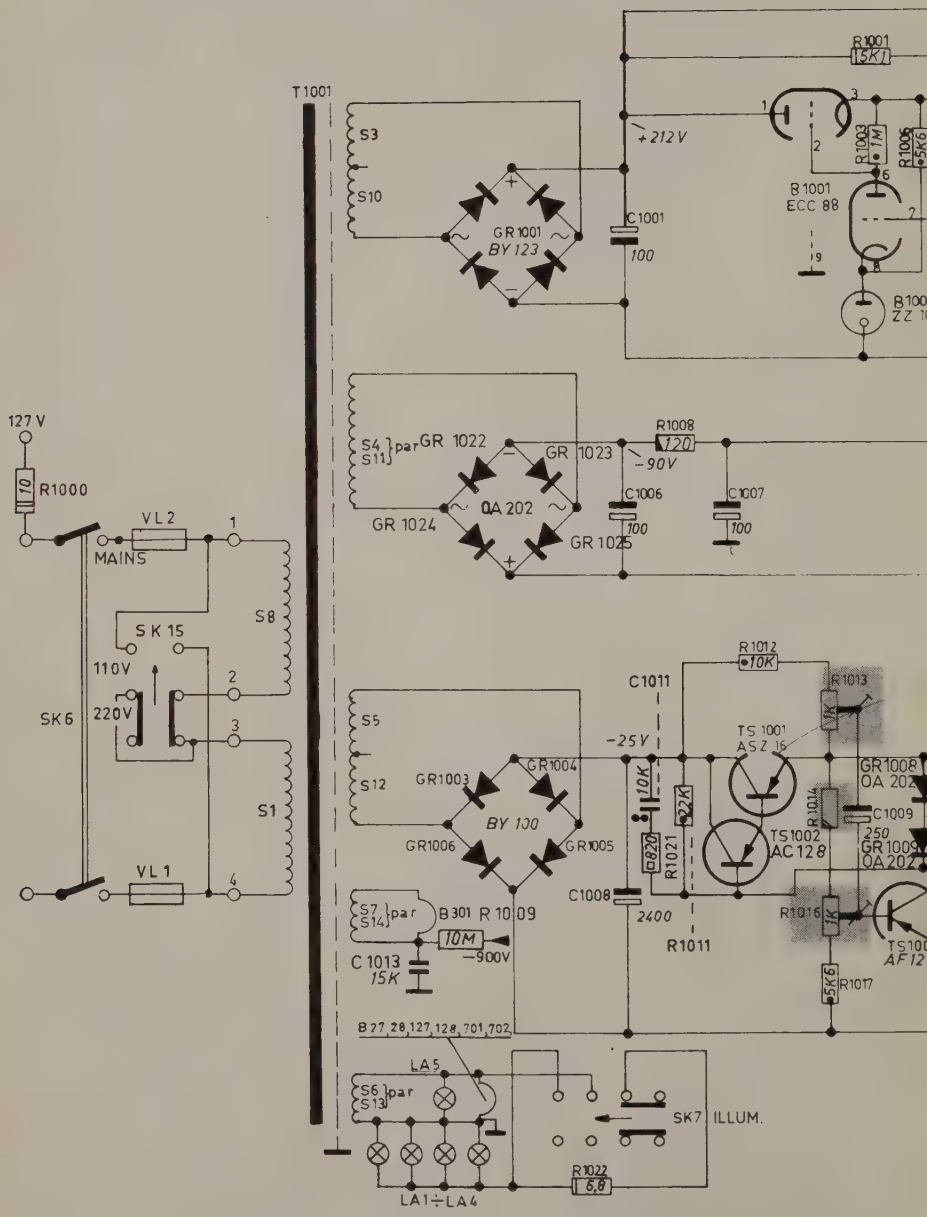
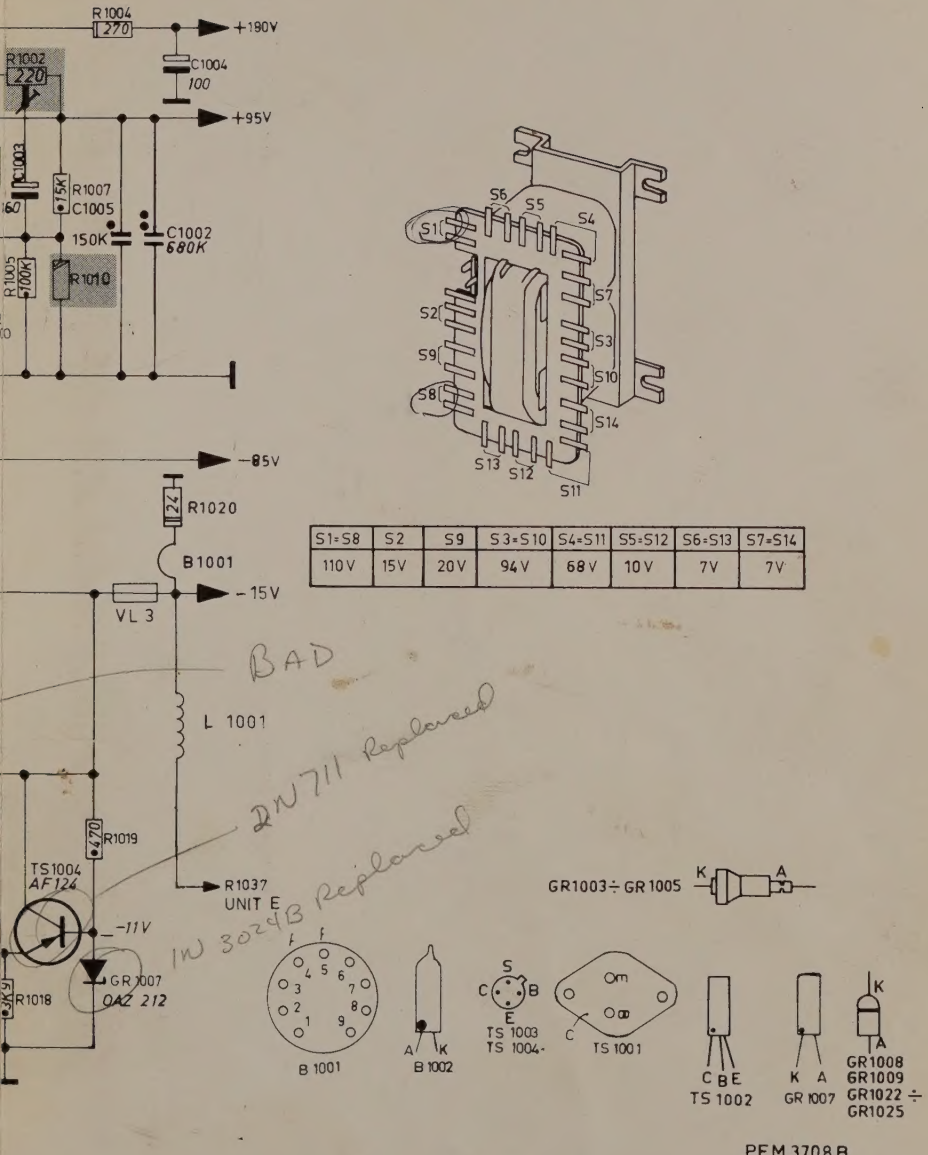


Fig. 33. Printed circuit, unit F


127 V
R1000
10
VL2
MAINS
SK 15
110V
220V
SK6
S8
S1
VL1
T1001
S3
S10
GR1001
BY 123
C1001
100
+212V
R1001
15K1
R1003
1M
R1005
5K6
B1001
ECC 88
S4 } par
S11 }
GR 1022
GR 1023
GR 1024
OA 202
GR 1025
-90V
R1008
120
C1006
C1007
S5
S12
GR1003
GR1004
BY 100
GR1006
GR1005
-25V
C1011
R1012
10K
R1013
TS 1001
ASZ 16
R1014
C1009
250
GR1008
OA 202
GR1009
OA202
TS1002
AC128
R1021
R1011
C1008
2400
R1016
TS10
AF12
R1017
S7 } par
S14 }
B301 R 1009
10M
-900V
C 1013
15K
B27,28,127,128,701,702
LA5
S6 } par
S13 }
SK7
ILLUM.
R1022
6,8
LA1÷LA4



S1÷S8	S2	S9	S3÷S10	S4÷S11	S5÷S12	S6÷S13	S7÷S14
110V	15V	20V	94V	68V	10V	7V	7V

Fig. 34. Circuit diagram-power supply

Italia: Philips S.p.A., Casella Postale 3992, Milano; tel. 69.94
Liban: Philips Liban S.A., P.O.B. 670, Beyrouth; tel. 232303-232458/59
Malaya: Philips Singapore Ltd., P.O.B. 1358 N.T.S. Building, d'Almeida Street, Singapore; tel. 94914
Maroc; Société Anonyme Marocaine de Télécommunications, Place Lemaigre Dubreuil, Casablanca; tel. 439-92
Mexico: Philips S.E.T., Apartado Postal 24420, Mexico 7 D.F.; tel. 25-15-40
Nederland: Philips Bedrijfsapparatuur Nederland N.V., Boschdijk VB, Eindhoven; tel. 3-33-33
Ned. Antillen: Philips Antillana N.V., Postbus 523, Willemstad, Curaçao
New Zealand: Electronic Development and Applications Co. Ltd., 18-20 Lorne Street, P.O.B. P.O.B. 2097, Wellington; tel. 54-039
Nigeria: Philips (Nigeria) Ltd., Philips House, 6, Ijora Causeway, P.O.B. 1921, Lagos; tel. 56051/2
Nippon: Philips Products Sales Corporation of Japan, Kokusal Building, 7th Floor, Marunouchi, Chiyoda-Ku, Tokyo; tel. (216) 2441
Norge: Norsk A.S. Philips, Postboks 5040, Oslo; tel. 463890
Österreich: Philips GmbH, Abt. Industrie, Triesterstrasse 64, 1101 Wien X; tel. 64 55 11
Pakistan: Philips Electrical Co. of Pakistan Ltd., Bunder Road, P.O.B. 7101, Karachi; tel. 70071
Paraguay: Philips del Paraguay S.A., Casilla del Correo 605, Asunción; tel. 8045-5536-6666
Perú: Philips Peruana S.A., Apartado Postal 1841, Lima; tel. 34620-40265
Philippines: Electronic Development & Application Center, Room 715, Don Santiago Bld., 1344 Taft Avenue, Manila
Portugal: Philips Portuguesa S.A.R.L., Rua Joaquim Antonio d'Aquiar 66, Lisboa; tel. 683121/9
Rhodesia: Philips Rhodesian (Private) Ltd., P.O.B. 994, Gordon Avenue, Salisbury; tel. 29081
Rwanda: Philips Rwanda S.A.R.L., B.P. 449, Kigali
Schweiz-Suisse-Svizzera: Philips A.G., Binzstrasse 18, 8027 Zürich 3; tel. 051 44 22 11
Singapore: Philips Singapore Ltd., P.O.B. 1358, N.T.S. Building, d'Almeida Street, Singapore 1, tel. 94914
South Africa: South African Philips (Pty) Ltd., P.O.B. 7703, 2, Herb Street, New Doornfontein, Johannesburg; tel. 24-0531
Suomi: Oy Philips Ab, Frederikinkatu 48, Helsinki; tel. 10915
Sudan: Gellatly Hankey & Co. (Engineering) Ltd., P.O.B. 150, Khartoum; tel. 71183
Sverige: Svenska A.B. Philips, Fack, Lidingövägen 50, Stockholm 27; tel. 08/635000
Syrie: Philips Moyen Orient S.A., P.O.B. 2442, Damas; tel. 18605-21650
Taiwan: Yung Kang Trading Co. Ltd., 6 Nan King East Road, 1, Section, P.O.B. 1467, Taipei; tel. 43540
Thailand: Philips Thailand Ltd., 283 Silom Road, Bangkok; tel. 36985-8
Tunisie: Société Tunisienne d'Industrie Electronique et de Télévision, 32 bis Rue Ben Ghedhahem, Tunis
Türkiye: Türk Philips Ticaret A.S., Posta Kutusu 504, Istanbul; tel. 447486
Uruguay: Philips de Uruguay, Avda Uruguay 1287, Montevideo; tel. 956 41-2-3-4
U.S.A.: Philips Electronic Instruments, 750 South Fulton Ave., Mount Vernon, N.Y. 10550-(914) 664-4500
Venezuela: C.A. Philips Venezolana, Apartado Postal 1167, Caracas; tel. 72 01 51
Zambia: Philips Electrical Ltd., Freetown Road, P.O.B. 553, Kitwe; Philips Electrical Ltd., P.O.B. 1878, Lusaka